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MUSEUM

OF

ECONOMIC GEOLOGY,

AND

MINING RECORDS OFFICE.

16

ACCOUNT

OF THE

MUSEUM OF ECONOMIC GEOLOGY,

AND

MINING RECORDS OFFICE,

ESTABLISHED BY GOVERNMENT,
IN THE DEPARTMENT OF HER MAJESTY'S COMMISSIONERS OF
WOODS AND FORESTS,

UNDER THE DIRECTION OF
SIR HENRY DE LA BECHE, F.R.S. F.G.S.

Nos. V. & VI., CRAIG'S COURT, CHARING CROSS.

BODLEIANA · BIBLIOTHECA

BY
T. SOPWITH, F.G.S.
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AUTHOR OF A TREATISE ON ISOMETRICAL DRAWING;
ACCOUNT OF MINING DISTRICTS, ETC. ETC.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
MDCCCXLIII.

LONDON: W. CLOWES AND SONS, STAMFORD STREET.

PRELIMINARY NOTICE.

THE Museum of Economic Geology, No. 6, Craig's Court, Charing Cross, is open to the public gratuitously every day in the year, Sundays, Good Friday, and Christmas Day alone excepted, from 10 o'clock in the forenoon to 4 in the afternoon in winter (November to February, both inclusive), and until 5 o'clock during the rest of the year.

The name and address of each visitor are required to be inserted in a book, which is kept for that purpose at the entrance of the Museum.

The Office of Mining Records, adjoining the Museum, may be seen on application to Mr. T. B. Jordan, who is daily in attendance, subject to such regulations as may be necessary in order to afford suitable accommodation for the examination of plans, models, &c., as described in pages 9 and 49 of the following work.

These valuable institutions are in the department of Her Majesty's Commissioners of Woods and Forests, and are placed by them under the immediate control of Sir Henry De la Beche, as Director.—Mr. Richard Phillips, F.R.S., is the Curator of the Museum, and Mr. T. B. Jordan, the Keeper of Mining Records.

The following account has been drawn up and published, from a conviction that this Museum eminently deserves to be extensively known, inasmuch as it is not less important for the objects sought to be attained, than it is interesting and instructive from the varied and popular nature of its contents. The author has much pleasure in acknowledging the facilities and information rendered by the above-named gentlemen, and also some other valuable communications, which are noticed in the following pages.

T. S.

NEWCASTLE-ON-TYNE.

"THE AVERAGE VALUE OF THE ANNUAL PRODUCE OF THE MINES OF THE BRITISH ISLANDS AMOUNTS TO THE ENORMOUS SUM OF 20,000,000*l.*, OF WHICH ABOUT 8,000,000*l.* ARISE FROM IRON, AND 9,000,000*l.* FROM COAL.

"SHOULD THIS INQUIRY (THE BEARING OF GEOLOGICAL RESEARCHES AND MINERAL STATISTICS UPON POLITICAL ECONOMY) BE EXTENDED THROUGH THE ENDLESS DEPARTMENTS OF ART, INDUSTRY, AND COMMERCE, WHICH HAVE THEIR ORIGIN IN THE MANUFACTORIES OF METALS, AND IN THE POWER OF STEAM, DERIVED EXCLUSIVELY FROM THE APPLICATION OF COAL; THE VAST NATIONAL IMPORTANCE OF MINERAL STATISTICS, AND OF MODELS, MAPS, AND SECTIONS, ON WHICH ALONE THEIR DETAILS CAN BE EFFECTUALLY RECORDED, MUST BE APPARENT TO EVERY ONE."

ADDRESS TO THE GEOLOGICAL SOCIETY,
BY PROFESSOR BUCKLAND, P.G.S. 1840.

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INTRODUCTION.

THIS Establishment owes its origin to the suggestions of the present Director, who, in July 1835, submitted to the Chancellor of the Exchequer that the persons employed on the Ordnance Geological Survey had constant opportunities afforded them of collecting specimens illustrative of the application of geology to the useful purposes of life, or, in other words, of the mineral wealth of the kingdom, and briefly pointed out the advantages which would arise from these collections being placed in a room or rooms under the care of the Board of Public Works. The objects contemplated in making these collections were—to obtain specimens of the various mineral substances used for roads; for the construction of public works or buildings; to be employed for useful and ornamental purposes in the arts; or from which useful metals are extracted. These, it was submitted, should be arranged with every reference to instruction, and the situations from whence obtained carefully marked, not only on the specimens themselves, but also on good maps, by which means a large amount of information which was then scattered might be condensed and rendered easy of access to all persons interested therein; who would

MUSEUM OF EC

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thus be enabled to judge how far our known mineral wealth could be rendered available for any undertaking they might be required to direct, or be anxious to promote, for the ornament or good of their country. In order to render this information as complete as possible, it was proposed that the specimens should be accompanied by documents showing the uses of the several mineral substances, the cost at which they may be shipped or otherwise transported from the place where found, together with any other useful information, and that their dimensions should be such as to show the real character of each. As illustrations of the nature and of the utility of forming a Museum of Economic Geology, the following examples were enumerated, *viz.*, that it ought to comprise specimens of rocks, showing the geological character of each district with reference to agriculture, as well as to mines and buildings, inasmuch as the natural soils depend in a great measure on the rocks on which they rest, a large portion of them being formed by the decomposition of such rocks, and mixed with a variable proportion of animal and vegetable matter: to comprise also specimens of the ores of the various metals employed for useful purposes, so as to exhibit not only the mode of occurrence of these ores in veins, but also to explain the several processes by which they are fitted for the market, and the metals extracted from them; and, finally, models to show the different methods of extracting and raising ores and minerals from mines, their application to the useful and fine arts, and also mineral substances employed as personal ornaments, and the like, such as agates, rock crystal, &c.

It must be gratifying to the public to know that these clear and comprehensive views at once received the cordial approval and encouragement of government. Apartments were allotted for the collection which had been formed during the Ordnance Geological Survey; and in February, 1837, Lord Duncannon, then Chief Commissioner of Woods and Forests, requested the present Director, Sir H. De la Beche, to undertake the carrying out of these objects, which he has since done gratuitously, and with a zeal and efficiency which are evinced by the present state of this interesting and valuable institution.

In 1839, Mr. Richard Phillips, F.R.S., long distinguished as an analytical chemist of the first order, was appointed curator of the museum, to which a laboratory was attached, in which analyses of soils, minerals, or other substances, are made on very moderate terms, under regulations which have for their object the diffusion of correct scientific information to all persons desirous to obtain the same; and pupils are also received for instruction in analytical chemistry, metallurgy, and mineralogy. In the same year this establishment became the place of deposit for Mining Records; and in the following year Mr. T. B. Jordan, of Falmouth, was appointed keeper of the same; and the plans, sections, models of mines, machinery, and the workshops under the museum, in which many of them have been constructed, are placed under his immediate superintendence. For this office Mr. Jordan was peculiarly well fitted, having been educated in the mining districts of Cornwall, and having devoted much attention to science, besides being himself a good workman in the construction of the most delicate and exact instruments for astronomical purposes. Of these combined talents the models made under his care furnish abundant testimony, and to these are added an obliging disposition, which cannot fail to be appreciated by those who refer to him for information connected with his department of the museum.

The following notices of the Museum of Economic Geology appear in Dr. Buckland's address as president of the Geological Society in February, 1841. Referring to the geological memoirs or subjects of the preceding twelve months, Dr. Buckland said, "Among the most important of these events we recognize with gratitude, and confident anticipation of great advantage both to science and the arts, the establishment by Her Majesty's Government of an institution hitherto unknown in England, *viz.*, a Museum of Economic Geology. This is to be freely accessible to the public at stated periods, in the department of Her Majesty's Woods and Forests and Public Works, for the express object of exhibiting the practical application of geology to the useful purposes of life. In this museum a large store of valuable materials has already been collected and arranged, chiefly by the exertions and under the direction of Mr. De la Beche. In it will be exhibited examples of metallic ores, ornamental marbles, building-stones and limestones, granites, porphyries, slates, clays, marls, brick-earths, and minerals of every kind produced in this country, that are of pecuniary value, and applicable to the arts of life. Information upon such subjects, thus readily and gratuitously accessible, will be of the utmost practical importance to the miner and the mechanic, the builder and the architect, the engineer, the whole mining interest, and the landed proprietors. The establishment will contain also examples of the results of metallurgic processes obtained from the furnace and the laboratory, with a collection of models of the most improved machinery, chiefly employed in mining. A well-stored laboratory is attached to this department, conducted by the distinguished analytical chemist, Mr. Richard Phillips, whose duty it is, at a fixed and moderate charge, to conduct the analysis of metallic ores and other minerals and soils submitted to him by the owners of mines or proprietors of land who may wish for authentic information on such matters.

"The pupils in this laboratory are already actively employed in learning the arts of mineral analysis and the various metallurgic processes.

"A second department in the Economic Museum will be assigned to the promotion of improvements in agriculture, and will contain sections of strata, with specimens of soils, subsoils, and of the rocks from the decomposition of which they have been produced.

"To the last-mentioned collection, proprietors of land are solicited to contribute from their estates labelled examples of soils, with their respective subsoils; and all persons who wish for an analysis of any steril soil, for the purpose of giving it fertility, by the artificial addition of ingredients with which nature has not supplied it, may here obtain, at a moderate cost, an exact knowledge of its composition, which may point out the corrective additions which it requires. This portion of the museum will more especially exhibit the relations of geology to agriculture, in so far as a knowledge of the materials composing the sub-strata may afford extensive means of permanent improvement to the surface.

"A Museum of Economic Geology, comprehending institutions of this kind, demonstrates even to the unlearned the advantages that result from science in its application to the extraction of the treasures which providence has laid up in the rich storehouses of the interior of the earth; and by exhibiting the results obtained from the elaboration of these materials by the industry of man, in the workshop and at the forge, will afford a full and satisfactory reply to the question so often raised by persons to whom the value of the truths of pure science and philosophy, pursued for their own sake, are unintelligible, and by whom everything is appreciated merely according to its immediate subserviency to the acquisition of wealth, or its ministration to the daily necessities or conveniences of human life."

From these preliminary notices it will at once appear that this institution is based on solid grounds, and promises ere long to attain an importance commensurate with its utility, and corresponding in some degree to the mineral riches of Great Britain, the value of the subterranean produce of which amounts annually to upwards of twenty millions sterling. The cost of the establishment hitherto has been very small, and the expenditure need not at any time be considerable, inasmuch as it is in the power of almost every proprietor of land or mines, or of their agents or others interested in practical science, to furnish specimens; and there is little doubt that, when the practical advantages of such a collection are fully known, the liberal examples already shown will be abundantly followed.

MUSEUM OF ECONOMIC GEOLOGY.

THE Museum of Economic Geology and Office of Mining Records are situated at Nos. 5 and 6, Craig's Court, Charing Cross, in the immediate vicinity of the Establishment of the Commissioners of Woods and Forests, under whom, as also constituting the Board of Public Works and Buildings, the general management of the museum is placed, its immediate direction being intrusted to Sir Henry De la Beche, whose geological works, added to his long-continued and active services in the direction of the Ordnance Geological Survey, and his gratuitous and effective management of this museum, render him one of the ablest promoters of geological science this country has produced. In the infancy of geology the attention of its ablest students was directed to theory rather than to practical results; but it is from the latter that we must ever derive the greatest advantages, and especially from those departments which come within the comprehensive scope of economic geology. Of these advantages the museum in Craig's Court affords a striking exemplification; and the following notices are intended to point out the leading circumstances which merit attention in the present state of the collection, by a general description of the several apartments and galleries, and of the principal objects already contained in them. It is also proposed to direct attention to the numerous and valuable opportunities possessed by land and mine owners, by their agents, and indeed by the public at large, of contributing specimens from their respective localities, and thus adding to the value and interest of this truly national museum.

It is not intended to insert a catalogue of the numerous specimens and objects of interest in the museum, but to give such a general description as may enable those who have not yet visited it to comprehend its utility and importance, and may serve also as a handbook to guide the stranger in a leisurely inspection of it. A catalogue would be necessarily imperfect in a collection which, though already rich, is daily receiving fresh additions, and will doubtless be much increased when the objects and advantages of the establishment are generally known. The explanatory labels attached to the specimens are more convenient and useful than any reference to a catalogue could be, inasmuch as the eye rests at once upon the specimen and its name, locality and uses; and in many instances the analysis of the ores and minerals is also given, this being one of the special objects contemplated, in order that visitors from different parts of the country may at once become acquainted with the nature and value of the various contents of the museum. The central position of Charing Cross, approached as it is at all times of the day by public conveyances from every part of London, affords an excellent opportunity for persons interested in such studies to avail themselves of the opportunities afforded by this museum, which is open every day throughout the year (Sundays, Good Friday, and

Christmas-day alone excepted), from 10 in the forenoon to 4 o'clock in winter (November to February inclusive), and until 5 o'clock the rest of the year. On entering Craig's Court, the buildings (No. 6) containing the museum present a frontage of fifty feet on the south side of the court, and the entrance to the Office of Mining Records is by the door, No. 5, immediately adjacent. This department having for its objects matters which concern particular parties rather than the public generally, is, from the nature of many of its contents, not open to indiscriminate admission, but every reasonable facility is afforded to all operative miners, as well as owners and agents of mineral property, or others interested in the examination of mining records and models of mining implements and machinery, on application to the keeper of Mining Records (Mr. T. B. Jordan), who is in attendance during the hours already stated.

In front of the museum are five stout posts of granite. These were specimens sent for the selection of the posts or columns employed in the centre part of Trafalgar Square. Commencing at the post near the door No. 5, the first is from Aberdeen, the second from Peterhead, the third from Penryn in Cornwall, the fourth from near Dublin, and the fifth from Dartmoor; the two last are solid blocks, the others are in two or more blocks: having been sent as specimens, they may be considered good examples of granite for building purposes.

The Museum of Economic Geology, as now arranged, comprises an entrance-hall or lobby; an apartment on the ground floor 46 feet long and 18½ feet wide, and a gallery on the first floor 103 feet long, varying in width from 17 to 25 feet. The department of the

Office of Mining Records comprises a Record Office 26 feet by 25 feet, in which are tables for drawing plans, and a gallery on the second floor 103 feet long, containing mining implements, and models of mines and mineral districts, and of various engines, machines, &c., used for working and draining mines. In addition to these are a laboratory, conducted by Mr. Richard Phillips, F.R.S., the curator of the museum; a workshop in which models are constructed, under the immediate direction of Mr. Jordan; and a small library or private room for the use of the director. To these apartments additions will doubtless be made from time to time commensurate with the national usefulness of the establishment, and the more so, as, owing to the extensive opportunities afforded by Ordnance Geological Surveys, and the great liberality of numerous owners of mineral property, and other public-spirited friends of science, a large proportion of the valuable contents of this museum have been, and will assuredly continue to be, received without any expense beyond the mere carriage of the specimens. It is gratifying also to know that the present administration cordially approve and support the arrangements of this museum, which was commenced by their predecessors, and by their attention to its interests evince their regard for those foundations of our national wealth, a knowledge of which, as Sir John Sinclair has justly said, is of more importance to this country than all the mines of Mexico and Peru.

In the entrance-lobby a beautiful vase of cast-iron, four feet high, designed by Edington of Glasgow, rests on a polished block of Peterhead granite, 3 feet high and 2 feet 8 inches square. The vase is remarkable as a good specimen of casting, all its details being as clear and sharp as its general contour is creditable to the talented designer who presented it to the museum. And here it may be useful to remark, that a plain and broad line has been very properly drawn by Sir Henry De la Beche, as regards the selection of specimens and works of art,—utility, and not mere ornament or temporary gratification, is the object in view. It is, therefore, only such specimens as possess an economic value that can find a place, and these are required to be sufficiently large to afford a correct idea of their structure, colour, &c. The works of art which come within the scope of this museum are such as strikingly illustrate the application of the products of the earth to useful and ornamental purposes, and it is essential that they should at the same time possess the highest merit of which each manufacture is susceptible. By this means the visitor, whether previously acquainted with geology or not, may see the ore as it appears in the lodes or veins whence it is extracted, the several changes it undergoes in being washed or dressed, and smelted, the mode of applying it to different manufacturing purposes, and finally, examples of the best specimens of art in each department. The names of the manufacturers are attached, and the eminent talents and zealous care of the director in adhering to these conditions must render the museum a valuable place of reference for information, as well as for interesting studies; and when these liberal and enlightened views are generally known, they will assuredly be cordially hailed by the intelligent portion of the community as truly worthy of the encouragement and support of every government.

The entrance-lobby contains some specimens of polished marble columns, two of which are from Plymouth, two from Babbacomb in Devonshire, one from Chudleigh, and another from Ipplepen, Devonshire.

FIRST APARTMENT ON GROUND FLOOR.

COLLECTION OF BRITISH BUILDING-STONES, INCLUDING GRANITES, PORPHYRIES, SERPENTINES AND MARBLES, EARTHS, &c.,

AND

THEIR APPLICATION TO THE USEFUL AND FINE ARTS.

One of the most interesting collections which is presented on entering this room consists of the various specimens of building-stone procured by the Commissioners appointed in 1838 to visit the quarries, and to inquire into the qualities of the stone to be used in building the New Houses of Parliament. The Commissioners were Charles Barry, Esq.; H. T. De la Beche, Esq., F.R.S. and F.G.S.; William Smith, Esq., D.C.L.; and Mr. Charles H. Smith, who made a tour of inspection in the months of August, September, and October in that year, in order to examine not only the quarries, but also numerous public buildings. This inquiry was not extended to granites, porphyries, and the like, on account of the enormous expense of using them in decorated edifices, and from a conviction that an equally durable, and, in other respects, more eligible material, could be obtained from the limestones or sandstones of the kingdom. Several specimens of granite, however, were received, and especially from the vicinity of Oban, in the west of Scotland, the property of the Marquis of Breadalbane, who munificently offered to the nation a free gift of his interest in any quantity that might be required, if it should be considered fit for the proposed New Houses of Parliament. The valuable services of Professors Daniel and Wheatstone, of King's College, London, were also employed in determining the physical and chemical properties of a large proportion of the specimens obtained. The Report of the Commissioners contains much valuable information on building-stones, and results in a preference being given to limestones, on account of their more general uniformity of tint, their comparatively homogeneous structure, and the facility and economy of their conversion to building purposes. Of this class they especially prefer those which are most crystalline, and finally recommend the magnesian limestone or dolomite of Bolsover Moor and its neighbourhood, as the most fit and proper stone to be employed in the New Houses of Parliament. This selection was based upon its durability, as evinced by the sharp and clear mouldings, and even the chisel marks, in parts of Southwell Church, built in the 10th and 12th centuries, and upon the result of experiments which are detailed in tables accompanying the Report. The specimens consist of six-inch cubes, 197 in number: they were directed to be placed in this museum by order of the Lords of the Treasury, and are arranged according to their mineral composition, together with the Report of the Commissioners, which can be bought at Hansards', or obtained from them by any bookseller for sixpence.* This collection furnishes the most valuable and instructive lesson in practical building that this country has ever furnished. The specimens are enclosed in glass cases, each compartment containing from 27 to 30 of them, with explanatory labels attached, showing the designation of the stone, the locality whence obtained, and the names of public buildings in which it has been employed. Thus, for instance, the first case on entering contains limestones and oolites, and among them are,—No. 19, Magnesian Limestone from Bolsover, in Derbyshire, employed at Southwell Church and New Houses of Parliament; 31, Magnesian Limestone from near Mansfield, Nottinghamshire, employed at New Houses of Parliament for a portion of the mouldings and carvings. In the first row of cases facing the entrance, are specimens of the stone employed at York and Ripon Minsters, the Cathedrals of Lincoln, Salisbury, and Exeter, Byland Abbey, the Church of St. Mary Redcliff, and the baronial mansions of Belvoir, Blenheim, Castle Howard, Chatsworth, Drayton Manor, &c. Here also are specimens of oolite limestones from Grove quarry, used in building St. Paul's Cathedral, and many of the churches in London, and from Coomb Down, Bath, employed at the restoration of Henry the Seventh's Chapel.

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* Report of Building-Stone Commission, 27th Aug. 1839, No. 574.

On the opposite side of the same case are 59 similar specimens, among which are the sandstones used at Hampton Court and Windsor Castle, the Royal Exchange and Bank at Glasgow, the spire of Tron Church, Edinburgh, the works at Dundee Harbour, the Castles at York and Barnard Castle, the commercial buildings at Leeds, and the new streets erected by Mr. Grainger in Newcastle-on-Tyne.

From the examples here enumerated, it will at once appear that from whatever part of the kingdom the visitors may come, they will observe the kind of building-stone prevalent in their locality, or used in public buildings with which they are familiar. They can then institute a comparison with similar stones from other districts, and as a further example of the information to be acquired, and as illustrating the nature and objects of the study of economic geology, the following particulars of one of these specimens are given from the report already mentioned.

BOLSOVER.—The stone obtained on Bolsover Moor, Derbyshire, is very generally sawn into slabs for paving, &c. (the name of nearest post town, of the owner and his agent, and the name and address of quarryman, are given in every instance). Its mineral designation is Magnesian Limestone: its component parts are chiefly carbonate of lime and carbonate of magnesia, semi-crystalline, its colour light yellow. A cubic foot of it weighs 151 pounds 11 ounces; it lies in numerous beds from eight inches to two feet thick, to the thickness or depth of twelve feet of workable stone. Blocks of 56 cubic feet may be obtained; and the price of block-stone at the quarry is 10*d.* per cubic foot (The cost prices enumerated by the Commissioners were furnished to them by the several parties interested, without reference to a large supply, which would doubtless occasion new and more economical arrangements to be made). The mode and cost of conveyance to London is described in each instance, and in the present one amounts to 16*s.* per ton. The cost of stone delivered in London, 2*s.* per cubic foot. The cost of plain rubbed work per superficial foot is the same as that of Portland stone in London. The chemical analysis is as follows :—

Silica	3·6
Carbonate of lime	51·1
Carbonate of magnesia	40·2
Iron and alumina	1·8
Water and loss	3·3
	100·

The specific gravity of a dry mass of this stone is 2·316, and of particles 2·833. The weight in the ordinary state of a cube of two-inch sides 4890·8 grains. The weight of the same, when well dried, 4881·4 grains. Weight, when saturated with water, 5042· grains, being an absorption of 160·6 grains of water, the proportion in bulk of which, as compared with the bulk of a two-inch sided cube, or eight cubic inches, for unity, is 0·079. (One specimen of magnesian limestone from Cadeby, near Doncaster, absorbed one-fourth of its bulk.) The weight of particles disintegrated after the two-inch sided cube had been subjected to Brard's process for eight days was one and a-half grain. The details of this process are described in vol. xxxviii. of the 'Annales de Chimie et de Physique,' and it is considered to represent very closely the action of the atmosphere during successive winters. The cohesive strength of the stone, or resistance to pressure, was ascertained by means of a hydrostatic press, and is given in one of the tables, with an explanation of the data on which the experiments were founded.

This example is given as an illustration of the study which may be profitably pursued by architects and builders, and as exhibiting the value of that connexion of physical sciences which is brought in aid in the selection of the best building-stone. It may also suggest to persons resident in the country the method of experimenting and reporting upon the quality of building-stones submitted to their investigation, and probably induce numerous proprietors of quarries to furnish six-inch cubes, accompanied with more or less of the above information, in addition to the name of the quarry, and of the buildings where it is employed. With the Report of the Commissioners any one at the Museum of Economic Geology may, in a few hours, obtain a greater amount of knowledge respecting the principal building-stones in the kingdom than could previously have been gained by a tour of some months to nearly 200 quarries, followed by a vast number of chemical and mechanical experiments. This collection, therefore, points out, in a manner which every one must clearly comprehend, the great practical value, as well as interesting nature, of the science of economic geology.

THE SECOND ROW OF CASES contains equally instructive specimens of *axe-dressed* and *fine axe-dressed* GRANITE from Devonshire and Aberdeen. Granite from Jersey, and several specimens of building-stone, among which are the sandstones employed at Tintern Abbey; at Wynyard, the seat of the Marquis of Londonderry; and at the Victoria Bridge, over the river Wear, in Durham. A specimen from Talacre is shown, with a quatre-foil beautifully carved, to show its fitness for mouldings and ornamental tracery. The second compartment of this case is filled with a rich collection of specimens of GRANITE and ELVAN,* the general structure, mineral composition, mode of occurrence, and economic uses of which, are detailed at great length, and with great clearness, in the able Report on the Geology of Cornwall, Devon, and West Somerset, by the director of this museum, and published by order of the Lords of the Treasury in an 8vo volume of 648 pages. This work forms the proper hand-book for those who are desirous fully to understand the nature and uses of the mineral products of these counties; and with it the specimens of granites, elvans, and the ores of tin, copper, &c., furnish a means of study accessible at all times without cost, whilst even the most cursory inspection of these beautiful mineral productions of our native country cannot fail to occasion surprise and delight,—surprise, at the abundance and richness, which comparatively few persons are acquainted with; and delight, arising from their wonderful variety and adaptation to use, which furnish incontestible evidence of Almighty skill. The polished surfaces of granite and elvan from Cornwall, Ireland, Scotland, Guernsey, &c., exhibit the mineralogical structure in a remarkably clear manner; and descriptive labels are attached, which supersede the necessity of enumerating each variety or locality. Nos. 112 and 113, presented by J. S. Enys, Esq., of Enys, in Cornwall, exhibit the granites used in the

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* A Cornish term for *dyke*. Long lines of granitic and felspar-porphy-

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ritic rocks in Cornwall, cutting the slates and granites, occasionally traversing both in one continuous body of rock, which, in their general mode of occurrence, strongly reminds us of trap dykes, and from which they chiefly differ in mineral composition. They vary in breadth from a few feet to 300 or 400 feet; and, though comparatively narrow, many can be traced satisfactorily for several miles. Generally speaking, those elvans are composed of a felspatho-quartzose base, with crystals of felspar or of quartz, and occasionally of both these minerals in the same rock.—*Report on Geology of Cornwall, &c. De la Beche.*

erection of his own mansion at Enys (112); and the other at Carclew, in the same county, the seat of Sir Charles Lemon, Bart., M.P. For several of these specimens the museum is indebted to the Marquis of Breadalbane; and many of them were collected during the progress of the Ordnance Geological Survey.

THE THIRD ROW OF CASES contains a variety of marbles, alabaster, &c., from Derbyshire, Staffordshire, and Devon, in blocks of six-inch cubes. The polished surfaces of some of these specimens exhibit a distinct view of the encrinal and numerous other fossil contents of the carboniferous or mountain limestone. There are also in this case some highly-polished specimens of *serpentine* from Cornwall (so called from its variegated surface resembling the mottled and many-coloured skins of some serpents); and this exhibition of it abundantly justifies the statement of Sir H. De la Beche, that it has hitherto been most strangely neglected, as much of it, he observes, "is extremely beautiful, particularly where veins of red traverse the olive-green ground, mixed with lighter tints:" the variety of tints, he further observes, is almost endless, and especially notices a very hard and beautiful variety having a reddish base studded with crystals of diallage, which, when cut through and polished, shine beautifully, of a metallic-green tint in the reddish base. Blocks sufficiently large for chimney-pieces have been obtained; and, if the demand required, it is believed that much larger blocks might be procured. Two or three cargoes of this rock (the Lizard Serpentine) are annually shipped to Bristol, to furnish magnesia for the sulphate of magnesia there manufactured. The third case contains also several specimens of marbles from the Isle of Man, Jersey, Guernsey, Glamorganshire, Clifton, Pembrokeshire, and the Hebrides, some of which are turned into handsome vases.

In the FOURTH ROW OF CASES are examples of encaustic tiling, and of the tesseræ manufactured by Messrs. Minton and Company (under Mr. Prosser's patent), from clay in a state of dry powder being subjected to violent pressure, and then vitrified. These tesseræ are prepared in small pieces of various forms and colours, which may be combined in any required forms of ornament, some specimens of which in a finished state are also here seen. Another compartment shows specimens of decomposed granite, from the felspar of which (easily separated by washing) China clay is prepared; and several beautifully manufactured articles of this material, as well as the application of the coarser materials, obtained in the washing process, to the making of fire-bricks. Some of the ornamental specimens exhibit the surprising grace and delicacy of execution of which the finest description of clays are susceptible, especially a group of flowers, which reminds the spectator of the marvellous lightness and elegance of the carvings in wood by Gibbons, while it shows how far that great master can be surpassed in this more fragile material. Two greyhounds, and several other beautiful specimens made from the Morley China clay, were presented by Lord Morley. Several recently-made vases of Etruscan form show how closely the ancient models can be followed, not only as regards a graceful contour, but also in the introduction of scrolls and figures. In some specimens in this and other parts of the museum, artists as well as artisans may, with great advantage, observe how slight a bend or other deviation from regular forms impart a degree of tasteful elegance, in which study there is much room for improvement in the various departments of English manufacture. These cases contain some cameos of exquisite workmanship, examples of the higher departments of art to which the earths of this country may be applied, and which thus come within the comprehensive range of economic geology.

THE FIFTH ROW OF CASES contains illustrations of the manufacture of earthenware in ancient as well as modern times; a specimen of antique pottery from a tomb near Smyrna; ancient Mexican pottery, and handle of a Mexican vase (Capt. Vetch, R.E.); ancient tazzo, of graceful contour, found in Barbary, between Tripoli and Fezzan; and an ancient Terra Cotta figure, presented by Mr. W. J. Smith; ancient encaustic tiles, &c., specimens from the Cambrian pottery, Swansea (L. L. Dillwyn, Esq.). These comprise samples of the several enamel and common or biscuit colours employed in manufacturing earthenware, with specimens of unbaked clays; baked clays or biscuit; biscuit coloured and glazed, and biscuit enamel glazed. There are also examples of copies of fossils formed of earthenware, and baked into biscuit, one of which in coloured clay represents a specimen of *Pentacrinus Briareus*, from the lias of Lyme Regis.

A coarse vase of the commonest earthenware from Picardy, of handsome contour, and tastefully ornamented with vine leaves and grapes, shows how much elegance is compatible with the meanest materials.

By exhibiting the several varieties of clay in juxtaposition with the articles made therefrom, much useful information may be afforded. Thus, for instance, the different materials may be studied with a view to comparing them with the products of other districts, and thus tend to investigations which may prove of great value to the owners and occupiers of properties in which mineral substances abound. It would be useless here to enumerate the particulars of a series admitting of frequent and valuable additions; suffice it to observe, that examples of draining tiles, of ridge tiles to match slate in colour, strawberry tiles, &c., are labelled with the name of each, with the price at the place of manufacture, and the cost delivered in London, —thus furnishing the architect, the agriculturist, and, in short, every intelligent inquirer, with an encyclopædia of reference, so far as the useful products of the earth are concerned, and diffusing knowledge on subjects which it is important should be extensively and correctly known. In this row of cases, also, are several specimens of the Seyssel asphalte, showing its different applications; and to each specimen a concise explanation is appended. The occurrence of gypsum under different circumstances, as in the marls of the new red sandstone series, &c., is shown by examples: a crystal of sulphate of lime or selenite (J. Tennant, Esq.), and several illustrations of Keene's marble cement, manufactured by J. B. White, are contained in this part of the museum. Some of these are imitations of Portland stone, others of statuary marble. The materials used in making it are placed alongside, in conformity with the general arrangement to be adopted of explaining the constituent parts of mineral or manufactured substances. One specimen of the application of this cement is a copy of an inlaid paving, nearly three feet square, from a mosaic at Scampton, near Lincoln; and the application of gypsum or plaster to the arts is shown by several examples, among which are a case of 27 medallions, Mercury and Pandora from Flaxman, Baily's exquisite figure of Eve at the Fountain, and a model of the Nelson Column with the National Gallery and adjacent buildings in Trafalgar Square, to show the applications of this substance to sculpture and architecture. There is also a copy of the "Morning" of Thorswalden in Roman cement, and a head of Apollo in Keene's cement, closely resembling a well carved marble bust.

In this room are several specimens of slate from Penrhyn Quarry, near Bangor, and other parts of Wales, showing as well the quality of the slate as the different sizes used in roofing. The recesses in the wall are appropriated to examples of polished granite from Aberdeen; a large slab of serpentine and limestone from Connemara, in Ireland; and a large and curious specimen of carboniferous limestone from the mumbles near Swansea. A rectangular block of rose-coloured marble from the island of Tyree, in the Hebrides, is remarkable for its beauty. Over the entrance-door is a bold relievo in Benson, Logan, and Company's patent metallic cement, and over the fire-place adjoining is an example of it coloured in landscape, and polished. A model of the Luxor Obelisk is represented in Derbyshire marble.

In March, 1840, Mr. C. H. Smith, who was one of the commissioners appointed to inquire into the qualities of the stone to be used for building the Houses of

Parliament, made a valuable communication to the Royal Institute of British Architects, treating at considerable length and with great ability on the various stones used for building. He justly observes, that though for a long period the most refined taste in elegant architecture was extensively practised throughout this country, yet the *quality of the stone* seems rarely to have been considered further than for the *facility with which it might be wrought* by workmen. "Relics of long-departed grandeur," he observes, "either of the ecclesiastical or baronial order, abound in most parts of the kingdom: nearly all these beautiful works of our ancestors are constructed with stone from the immediate neighbourhood of such buildings, apparently *without any regard to colour, strata, or durability;* and hence we frequently find stones of *very different tints* indiscriminately placed together in the same elevation—some *extremely perfect,* others in a *very mouldering condition.*"

The above is a valuable commentary on the chief uses to be derived from the collection of British stones, which forms a prominent feature in the apartment now described. It is lamentable to observe some of the finest works of art in public buildings of a few centuries utterly destroyed, while monuments of vast antiquity are brought from distant countries almost as perfect as when they were first executed, of which a walk in the sculpture galleries of the British Museum furnishes abundant examples. A curious work of art has been recently added to the Economic Museum, which proves that the ancients had no superiority over the moderns in their *power of working* hard and durable materials. It is an antique bust, copied from one of the Egyptian antiquities in the British Museum (No. 52, a bust broken from a seated statue of Bubastes). The material of which this copy has been made, by Mr. C. H. Smith, is a large-grained greenstone (formed of hornblende and felspar) from Llanwnda, near Fishguard, Pembrokeshire, and perfectly agrees in mineral composition and general aspect with the large-grained greenstones out of which the Egyptians cut so many statues, which yet endure, and promise to remain for ages to come, a testimony of their judicious selection of durable materials. Having no quartz in its composition, it is easier to cut than ordinary granite. Mr. Smith has obligingly favoured me with several particulars of the execution of the workmanship, which I here introduce not only for the novelty of the subject, but also as affording an example of the detailed information which it is desirable should accompany and be attached to each work of art in this museum. Steel tools, tempered to a dark straw-colour, were used, with an iron hammer; the cutting edge was sharpened rather obtusely, so as to produce a succession of moderate batterings, rather than to attempt cutting or getting off large pieces by violent blows. When brought to a general form, the bruised surface was rubbed with coarse emery and pieces of sheet lead, or bits of wood made to fit the various undulations. Finer emery with snake (or water-of-Ayr-stone) was then used, and ultimately putty powder gave as good a polish as the material was capable of receiving. The indentations were afterwards cut with a chisel and hammer. The time occupied in the operation was seventy-six days, and the cost of sculpture 25*l.*, exclusive of the trifling value of the stone.

FIRST GALLERY.

ORES OF THE USEFUL METALS:
BRITISH AND FOREIGN SPECIMENS
ILLUSTRATIVE OF THEIR
MODE OF OCCURRENCE IN LODES OR MINERAL VEINS; COALS, AND METALLURGICAL PROCESSES.

The visitor first enters the WESTERN DIVISION of this gallery, which is immediately above, and corresponds in size with, the room on the ground floor already described. It also contains five rows of cases filled with specimens of British ores, to which names and descriptions are attached.

THE FIRST CASE next the entrance is filled with large and instructive illustrations of the various states in which copper ore is found. Thus one specimen exhibits strings of copper ore in slate from mines in Cornwall, another shows the manner in which copper pyrites, and the other contents of a lode, are commonly mingled. Other specimens show a poor portion of a rich copper lode, samples of fair produce, and of very rich ores. The mode in which some of the Cornish and Devon tin lodes occur in granite is rendered apparent; and in a few minutes a better idea can be formed of these interesting phenomena than by a laborious exploration of some hours in the deepest mines of these districts.

THE SECOND CASE contains specimens of copper ores. Numbers 91 and 92 show what is called the comby structure; 93 and 94 are plates of quartz and copper pyrites; 95, combs or plates in which copper pyrites and blende are disseminated. In No. 122, a white vein traversing the specimen furnishes a miniature type of a lode or mineral vein crossing a slate country; and in the same specimen are fragments of copper pyrites, dispersed in the slate.

Numbers 138, 139, and 140, show that the cavity in which the branch of copper has been formed was lined by quartz on one side, and clayey matter and quartz on the other, before copper ore was introduced. In No. 141 may be seen the sudden termination of a vein of copper pyrites, an occurrence which sometimes takes place on a much larger scale, to the serious disappointment of the miner, whose hopes and labours are thus suddenly brought to an end. No. 142 is a good example of copper pyrites, the walls or sides being removed. In No. 145 are strings of native copper in part of a lode; and the junction of copper lodes with the walls or sides of granite is shown in the specimens numbered 146, 147, 152, 153, 154, 163, and 165. No. 164 shows the parallel or comby arrangement of quartz nearest the wall of the lode, then follows blende, and afterward copper pyrites.

THE THIRD CASE contains varieties of tin ores, illustrating the phenomena of their occurrence in veins. The specimens numbered 229, 230, and 238, exhibit crystals of peroxide of tin, felspar, and quartz, constituting a sort of stanniferous granite, formed subsequently to the rent or fissure in the main mass of common granite traversed by the lode; no other lode resembling this was found in the progress of the Ordnance Geological Survey. In this case also are a great variety of lead ores from Devon, Cornwall, and Alston Moor, and showing the combinations of galena (sulphuret of lead) with calcareous spar, blende, copper, iron pyrites, &c.

The Fourth Case is appropriated to specimens of iron, and to illustrations of the various stages of its manufacture into different qualities of pigs and bars, in the first instance, and afterwards into implements, &c. The description attached to each specimen renders it unnecessary to do more than point out the general features of this department of the museum. Specimens of the coals and coke, and limestone employed, are contained in the same case, and a numerous and most instructive series of such specimens, explanatory of iron-making, from the Bowling Iron Works in Yorkshire, was presented by Messrs. Sturges.

Another valuable series, showing the different kinds of iron made at Sirhowy in Monmouthshire, was presented by the proprietors of these iron works. The geological structure of the district in which these ores are obtained is shown by a model in another department of the museum. D. H. Williams, Esq., has presented similar specimens from the Plymouth Iron Works, Merthyr Tydvil; and Sir John Guest, Bart., J. Pirie, Esq., and Sir H. De la Beche, have made important additions to this useful collection of iron ores,—an example which there is little doubt will be extensively followed by the proprietors of other works throughout the kingdom, who at a very trifling individual expense could thus furnish the means of presenting at one view a comprehensive survey of the ores and manufactured iron at all the principal works in the kingdom.

Several interesting illustrations of the manufacture of steel were presented by Messrs. Sanderson Brothers, and Company; they exhibit the several kinds of fracture of steel of different qualities, hardness, &c. Eleven small polished specimens, presented by W. H.

Pepys, Esq., show the colours produced by tempering at different degrees of heat; and another series illustrates Heath's patent welding cast steel (from J. M. Heath, Esq.), with a finished knife and spatula of the same. Several steel dies show the manner in which they are prepared for coining, with some medallion heads by Wm. Wyon, Esq., by whom this series was presented. Among the latter are a gold medal of the Queen, and a medal in platina of Earl Spencer; the geological medal of Wollaston in palladium, one of Cheselden in silver, James Watt in copper, and a Telford medal in bronze, of the same proportions as ancient bronze, viz., $\frac{1}{10}$ of tin to $\frac{9}{10}$ of copper.

THE FIFTH ROW OF CASES.—Specimens of argillaceous blackband, numerous other ores, and manufactured iron and steel, in various stages and qualities, presented by Wm. Murray, Esq., of Monkland. The discovery of the blackband iron-stone was made by David Mushet, Esq., of Coleford, in 1801, at Monkland. "At that time,"* he observes, "great prejudice was excited against me by the iron-masters and others of that day, in presuming to class the *wild* coals of the country with iron-stones fit and proper for the blast furnace. Yet that discovery has elevated Scotland to a considerable rank amongst the iron-making nations of Europe, with resources still in store that may be considered inexhaustible." The Airdrie estate has recently produced to its proprietor, Sir W. Alexander, a clear income of upwards of 12,000*l.* a-year (in 1839, 16,500*l.*), for blackband iron-stone alone, and where not one shilling of mineral rent was formerly received. It would be difficult to find a more striking evidence of the importance of economic geology, inasmuch as the *wild coal*, which now produces a princely revenue, was a few years ago suffered to lie useless in the earth, and the discoverer of its value treated with indifference and neglect, instead of being acknowledged and honoured as a public benefactor.

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* Papers on Iron and Steel, Practical and Experimental. By David Mushet. Weale, 1840.

Specimens of lead, as it appears under different stages of being washed, refined, &c., are contained in these cases; also specimens (presented by J. Taylor, Esq.) of the crystallized lead produced in Mr. Pattinson's process for separating silver, one of the most valuable discoveries of modern times.

The processes of dressing and smelting copper are also shown by numerous examples, accompanied with detailed descriptions, and presented by J. H. Vivian, Esq., M.P., W. E. Logan, Esq., and others. The mode of casting copper nails for sheathing is also exhibited, and these form but the commencement of an extensive and valuable collection illustrative of the uses of the metals in the arts. The different stages of reducing tin ores to a metallic state is shown by specimens from Wheal Vor Tin Mine in Cornwall, as follows:—

Crop Tin, as stamped, buddled, double buddled, tossed, burnt, burnt tossed, cased, and fit for smelting.

Slime Tin, as stamped, trunk-worked, coffer-worked, tossed, burnt, burnt tossed, cased, and tossed clean, with specimens also of metallic tin. These were presented by George S. Borlase, Esq., F.R.S.

These cases contain several other collections of ores in various stages of preparation, and a series of cubes of brass, copper, zinc, bell-metal, lead, bronze, block-tin, &c., illustrating the Cornish metals and their compounds.

A Sixth Case, at the further end of the room, illustrates the different stages of manufacturing swords and gun-barrels by Mr. H. Wilkinson, Pall Mall. There are 29 of these specimens, and each one is explained at length by a written description placed beside it. The barrel, No. 22, is composed of five different ribbons, or kinds of iron, technically called twice-twist, stub-twist, Damascus-twist, Damascus and wire united, and lastly stub-Damascus. The ingenuity and beauty of this manufacture are only equalled by the clearness with which the several processes in detail are rendered apparent.

In recesses of the wall opposite the windows are upright glass cases. The one nearest the entrance contains numerous examples of stones used for polishing, and as grindstones, &c., presented by Richard Knight, Esq. The name, locality, and peculiar use of each specimen is attached, and at one glance the eye comprehends the appearance of various kinds of sandstone, hone slate, and ragstone, pumice, emery, Tripoli,* bloodstone, agate, &c., and their use in polishing scythes, knives, cut glass, marble, copper-plates, &c., and for bookbinding, carving, &c.

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* The minuteness of the fossils of which Tripoli is composed is among the greatest wonders of microscopical research. Ehrenberg estimates that in the Tripoli of Bilin in Bohemia, where a stratum of it is spread over a wide area, a cubic inch contains forty-one thousand millions of the Gaillonella distans, or about *one hundred and eighty-seven millions in a single grain* (See Lyell's Elements of Geology, vol. i. p. 53.) Of this extreme minuteness and astonishing number it is difficult for the mind to form any clear conception. They may, however, be comprehended by considering that if the fossil remains could be counted one by one at the rate of one hundred every minute for ten hours each day, and three hundred days in each year, it would, even with this more than human industry, take a person more than *ten years* to count the numbers in a

THE SECOND UPRIGHT CASE contains numerous specimens of Russian polished rocks, granites, porphyries, gneiss, sienite, jasper, quartz, marbles, &c., presented by the Imperial Mining Institute of Russia.

IN THE THIRD UPRIGHT CASE are specimens of sulphur, illustrative of its sources and uses, from Charkow in Poland, Knabba in Iceland, and from Naples, Sicily, &c.: it is shown in the manufactured states of roll-brimstone, flowers of sulphur, and in its states of combination as sulphuric acid, and sulphates of iron, copper, zinc, &c. One of its applications to the fine arts is shown by a series of casts of gems.

The remaining upright cases in this room are occupied by miscellaneous collections, which are not yet finally arranged, but a brief enumeration of some of their present contents may direct the stranger to objects of interest, and also suggest to those disposed to add to the collection the description of objects which come within the scope of the museum. One important feature will be formed by a vitreous collection, for which many valuable specimens have already been received. It is intended to exhibit the materials of which glass is composed, specimens of its manufacture

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single grain weight, and at the same rate of counting it would require more than two thousand years to count the number contained in a cubic inch. The history of fossil infusoria abounds with instances which create surprise and admiration, and evince that the same infinite skill which guides the planets in their course, and adorns the realms of space with myriads of suns, can people also with millions of living creatures the very atoms of dust which almost elude the human sight.

in ancient as well as modern times, as applied to useful and ornamental purposes, and of the effects produced by various mineral substances in colouring glass, with the result in stained-glass windows, one of the many departments in which attractive beauty is added to geological interest in viewing the contents of the museum. Among the specimens of this series already in the cases are—

An ancient Egyptian necklace, presented by the Rev. Henry R. Lloyd, of Carew, Pembrokeshire.

Glass models (by Mr. J. Tennant) of celebrated diamonds, viz.—

The Nassuck	diamond	(7357½	grs.)	valued at 7,200*l.*
Austrian	do.	(522	do.)	do 9,250*l.*
Russian	do.	(779	do.)	sold for 90,000*l.* and an annuity of 4000*l.*
Grand Mogul	do.	(1184	do.)	
Blue	do.	(177	do.)	valued at 30,000*l.*
Pigott	do.	(196	do.)	do. 40,000*l.*
Pitt or Regent	do.	(547	do.)	sold for 135,000*l.*

Diamond in the collection of the Duke of Tuscany.

Specimens of incrusted glass inscriptions, one of which is broken to show the mode of formation. They were made and presented by Mr. Pellatt, who prepared in this manner one of the inscriptions deposited under the foundation-stone of the Royal Exchange in London. It appears to furnish an almost indestructible record. Small figures of China or other materials may in like manner be enclosed in glass, of which some specimens are shown: they are remarkable for the silvery lustre of the incrusted figure.

The upright case next the window at the further end of the room contains illustrations of the electrotype process applied to the copying of seals, medals, fossil remains, and is surmounted by a magnificent colossal bust of Ajax in electrotype copper, which is an excellent example of the application of electro-metallurgy to the fine arts. It is from the manufactory of Mr. Benjamin Smith, and is produced by depositing a thin coating of copper on a plaster cast, previously prepared by having its pores filled with oil and its surface covered with plumbago. When the copper deposit is sufficiently thick, the plaster is removed from the inside by chipping it out. The outside is then varnished, and an electro-deposit of copper added so as to strengthen the inside.

Many of the specimens in the case, by Mr. T. B. Jordan, are among the earliest experiments that were made in this country after the discovery of the process. One of these is an egg-cup made by Mr. Jordan, and exhibited with other specimens at a meeting of the West Riding of Yorkshire Geological and Polytechnic Society in September, 1841. It was formed by a deposit of copper on a brass block, and plated with silver outside and gold within. Many of the copied seals and medals are interesting as works of art. The copies of fossils are remarkably good, and show that, at a trifling cost, local museums might be furnished with accurate duplicates of even the most rare and valuable specimens, as impressions may be taken in wax or plaster without injury to the original; and by means of elastic glue, even undercutting, as it is termed, may be successfully cast and copied.

In a frame over the fire-place are six illustrations of the application of the electrotyping process to copying engravings. No. 1 is a copper-plate which was engraved by Gardener for De la Beche's 'Sections and Views Illustrative of Geological Phenomena,' published in 1830, and representing a portion of the earth, with parallel lines on the surface showing the height of the Alps, the Andes, and the Himalaya Mountains, and the exceedingly small proportion which even these lofty regions bear to the general mass of the earth; a greater and lesser circle show also the comparative size of the sun and earth—the former, shaded as a globe, is an exquisite specimen of hand engraving, the gradations of shade being effected solely by delicacy of touch.

No. 2 is an electrotype copy or impression of the above, and the lines consequently stand out in relief; but No. 3, which is an electrotype copy of No. 2, is exactly the same as No. 1; and beneath it and No. 1 are impressions on paper from each respectively, with a plain copper-plate between, formed by a deposit by the same process as Nos. 2 and 3. The latter is said to be preferred by engravers to common copper-plates, from its being of more uniform texture.

Over the fire-place at the opposite or east end of the room is a cast-iron relievo of Leonardo da Vinci's "Last Supper."

The second or EASTERN DIVISION of this Gallery contains specimens of the ores and useful metals of Great Britain, in horizontal cases, and foreign specimens of the same in upright cases, except in a narrower part of the gallery at the entrance, in which the cases both upright and horizontal contain specimens of the coals of Great Britain.

Commencing at the further or east extremity of the room, next the windows, the FIRST HORIZONTAL CASES contain numerous specimens of native copper, or copper in its metallic state, found occasionally in various parts of Cornwall, though seldom in large masses, and of other copper ores. A general description of the several varieties of minerals is written on blue cards; and the name, locality, and other particulars, on white cards, are placed near each specimen, with the names of the donors of a vast number of specimens. A few examples of these descriptions are here given, not for the purpose of reference at the museum, but to convey to those who have not visited it an idea of the method pursued by the able curator, and which might with great advantage be followed in provincial museums.

"Red Oxide of Copper, Oxidulous Copper; occurs in Cornwall, but not in large quantity; it is not separately reduced as an ore: it is a suboxide or dinoxide of copper, containing, when pure, oxygen 11·12, copper 88·88 = 100. Primary form of the crystal—the cube which passes into the octohedron and the rhombic dodecahedron. Specific gravity 6·0."

Four crystals of it, presented by Mr. Tennant, show, 1st. the cube; 2nd. the octohedron coated with malachite; 3rd. octohedron, having the edges replaced by six-sided planes, which, when increased, form No. 4, the rhombic dodecahedron. A large block of red oxide of copper was presented by John Hardy, Esq., Jun., from Cobre Mines in Cuba.

Similar descriptions and explanatory specimens of copper ores follow in the same case, the principle of arrangement being—First, native metals; then binary compounds, beginning with oxides and proceeding to chlorides, sulphurets, iodides, &c.; after these, ternary compounds, as oxichlorides and oxisulphurets; and these followed by combinations of the oxides with acids, as carbonates, sulphates, phosphates, &c.; to be followed by compounds of the ore with other ores, as copper pyrites, and their mixtures of various ores.

There are numerous specimens of black oxide of copper or black copper; green carbonate of copper or malachite; blue carbonate of copper; with several varieties of arseniates of copper (965 to 991), presented by G. B. Greenough, Esq.; a large specimen of cupriferous sandstone from Erdiston, near West Feltôn, in Shropshire (F. Bankhart, Esq.); copper pyrites or yellow copper ore, and tennantite, a variety of grey copper from Cornwall; purple copper ore (Buntkupfererz), a double sulphuret of iron and copper, which occurs in small quantities in Cornwall and Ireland, and is not separately smelted. Some beautiful specimens of this mineral were presented from Kenmare Mines, in Ireland, by Captain Ewbank, Thomas Cornish, Esq., and Dillon Croker, Esq. Several specimens exhibit copper pyrites with tin ore, arsenical pyrites, iron pyrites, blende, silver, &c.

In the same cases are varieties of oxide of tin or tin stone, from various parts of Cornwall, pebbles of stream tin, tin pyrites, &c. The mines from which copper and tin are obtained, and the methods of raising and dressing them, are shown by models in the Mining Records Department of the Museum. In the first row of cases also are specimens of native arsenic, native bismuth, carbonate and sulphuret of bismuth, sulphuret of antimony or grey antimony, &c.

The SECOND HORIZONTAL CASES contain native gold found in a tin-stream work near Truro in Cornwall;

gold from Gogofau, an ancient Roman mine near Caio, Caermarthenshire; native silver and ores from Herland Mine in Cornwall (Joseph Carne, Esq.); red silver ore from Dolcoath Mine; native silver, sulphuret of silver, and red silver, with carbonate of iron, from Wheal Brothers, Cornwall; native silver from Devonshire, &c.

"Galena (sulphuret of lead), the usual ore of this metal, found massive and crystallized. Primary form, the cube; secondary forms, the octohedron, &c.; is usually associated with calcareous spar and fluor spar, and generally contains silver, though frequently in too small a proportion to pay for refining. When pure, it consists of sulphur 13·4, lead 86·6 = 100; specific gravity 7·4 to 7·6." A number of specimens from various parts of Great Britain exhibit its crystalline forms, and show the manner in which it is usually found with fluor spar, carbonate of lime, &c. There are also specimens of sulphates and carbonates of lead, phosphates and arsenio-phosphates of lead, &c. The strata in which it is usually found, and the methods of working and washing it, are illustrated by models and sections in the Mining Records Office.

A large block of argentiferous galena, from Venezuela, in the province of Cumana, was presented by Col. Stopford.

In the second row of cases are also specimens of magnetic iron ore (loadstone), from Ilsington, Devon; Treluswell near Penryn, and Wicklow in Ireland. A variety of examples of hematite iron ore, or fibrous red oxide of iron, a large and beautiful specimen of which, from Ulverstone in Lancashire, was presented by Dr. Buckland. There are specimens also from Cumberland, Cornwall, Devon, Somersetshire, Glamorganshire, &c.;

and several pieces of black-brush and smith ore, from the Forest of Dean. Micaceous iron ore from Dartmoor (formerly used for writing sand), and a specimen of iron ore prevalent at a small depth in the country round Drayton Manor, presented by Sir Robert Peel, Bart., M.P., who, in an address to the members of the Tamworth Library and Reading-room, has expressed his lively co-operation in the pursuits of economic geology, observing that, "in a district not deficient itself in mineral productions, and bordering on one which is pregnant with iron and coal—the great incentives to human skill and industry—a collection of mineral specimens may perhaps gradually be formed, most interesting to the inquisitive mind, and *facilitating the comprehension of written treatises, or of lectures on mineralogy and kindred subjects.*" In the latter sentence, Sir Robert Peel has pointed out the principal use of the collection here described ; for it is not by mere inspection, which may please the eye without informing the mind, that useful or important results are to be anticipated, but by furnishing to every student, and to every practical miner or manufacturer, an extensive and well-arranged and explanatory collection of specimens, by examining which, the information obtained from reading or from lectures will be established and strengthened ; and still more to render this department of the museum useful to the utmost extent, it is intended that public lectures shall from time to time be given,—an object truly worthy of the liberality of an enlightened government, and one which promises to confirm, to strengthen, and to extend, the foundations alike of national welfare and of individual enjoyment.

In the Third Horizontal Cases are specimens of carbonate of iron on quartz, on copper pyrites, and mixed with lead ore; numerous specimens of argillaceous iron ore, an impure carbonate of iron, the pure portion of which is composed of carbonic acid, 38·—protoxide of iron, 62· = 100. The ore, on an average, consists of carbonate of iron, 62·—earthy matter, chiefly alumina and silica, 38· = 100; and yields 30 per cent. of iron. This is the principal ore of Great Britain, yielding the greater portion of the iron produced in it, and commonly called clay ironstone. It is very abundant in Staffordshire, Shropshire, Yorkshire, Northumberland, Durham, and in Scotland and South Wales.

A great number of the specimens are remarkably instructive, having been selected by Sir Henry De la Beche and his able assistants in the course of the Ordnance Geological Survey; a valuable series from Glamorganshire was collected by Mr. D. H. Williams. The specimen, No. 416, is a fossil plant, *sigillaria;* No. 418, a calamite; and Nos. 421, 422, and 433, have impressions of ferns—memorials of the vegetation which existed when the strata in which they are found were being deposited, or, as an eloquent writer has termed them, "Medals of Creation," recording the vast geological changes that have taken place at successive periods in the history of the globe.

Iron pyrites (bisulphuret of iron), when pure, consist of sulphur 53·4—iron 46·6 = 100. Among several specimens from Cornwall, one, numbered 395, is remarkable for the largeness of its crystalline cubes. Several fine specimens from Devon, Dorsetshire, &c., were presented by G. B. Greenough, Esq.

The FOURTH HORIZONTAL CASES contain specimens of blende (sulphuret of zinc), abundantly found in Cornwall, Derbyshire, and Cumberland, is commonly associated with galena, and when pure consists of sulphur 33·3, zinc 66·6; calamine (carbonate of zinc), an abundant ore of the metal, when pure, consists of carbonic acid 35·5, oxide of zinc 64·5 = 100.

Oxide of manganese; a number of specimens from Devonshire and Cornwall, collected and presented by Sir H. De la Beche.

The UPRIGHT CASES in this room contain foreign ores, &c. In the case on the left of the fire-place are specimens of the oxide, sulphuret, carbonate, and phosphate of manganese, from Prussia, Russia, Bavaria, &c.; and a collection of silver ores, from various mines in Mexico, presented by Major Charters, R.A. In the case on the right hand of the fire-place are native antimony from Grenoble; splendid specimens of sulphuret of antimony from Spain, Florence, Hungary, Harz, Prussia, Freiberg, &c.; blende from Brilon on the Rhine, Saxony, Bohemia and Hungary; calamine (carb. of zinc) from Kremnitz in Hungary, Silesia, &c.; red oxide of zinc from New Jersey in North America; peroxide of tin from Bohemia, Saxony, Russia; a vein of this mineral in gneiss from Gayer in Saxony; another vein of it in mica from Bohemia; oxide of nickel from Saxony; arsenical nickel from Silesia; varieties of cobalt from Saxony, Baden, Thuringia, and Norway; various crystalline forms of white or glance cobalt from Tunaberg in Sweden (G. B. Greenough, Esq.); native arsenic, Saxony; red sulphuret of arsenic, Transylvania;

arsenical pyrites in serpentine from Silesia; sulphuret of molybdenum from the Island of Virgin Gorda, West Indies, presented by the directors of the Mining Company; and several other minerals all properly labelled: among them is a large and beautiful specimen of plumbo-cupriferous sulphuret of bismuth, presented by the Imperial Mining Institute of Russia.

In the FIVE UPRIGHT CASES OPPOSITE THE FIREPLACE is a valuable collection of foreign ores, of which the following notice of their contents may suffice to afford a general idea, and also serve to guide visitors to any particular department they may wish to examine. Commencing from the east or window end of the room:—

The FIRST CASE contains specimens of native gold, in quartz, from the mines of Bérésow, in the Ural Mountains (Imp. Min. Inst. Russia); four specimens of native gold, presented by G. B. Greenough, Esq.; two specimens of native gold from Siberia, one of them extremely valuable, being a mass of octohedral crystals, the other detached crystals (Baron A. de Mayendorff).

Four specimens of auriferous (or golden) sand, from the Ural Mountains, one pound troy weight being obtained respectively from 174, 140, 190, and 213 tons of the sand.

Two specimens of platiniferous sand from the mines of Yegoro Kanskinskoi, in the Ural Mountains—one of them yielding from 1 to 5 troy pounds in 140 tons, the other from 1½ to 3 lbs. in the same quantity.

Native platina from Russia. Specimens of manufactured platina, fit for use, and a Russian platina coin, about the size of a shilling: its value is 3 silver rubles, or 9*s*. 7½*d*.

The SECOND CASE contains several specimens of native silver from the mines of Zmeinvgorsk—district of the Altai, Russia.

Silver ore, with native silver, from Catorse, Mexico (Major Charters, R.A.).

Auriferous silver ore, and sulphuret of silver, from Russia (Imp. Min. Inst.); argentiferous galena, with sulphurets of iron and zinc, and native silver coating crystals of quartz.

Specimens of sulphuret of silver from mines in Russia and Mexico, the latter presented by John Taylor, Esq.

Galena, from Harz, Freiberg, Russia, &c.; black carbonate of lead, galena, and arseniate of lead, and carbonate of lead with ferruginous clay, from the mines of Riddersk, district of the Altai, Russia (Imp. Min. Inst.).

The THIRD CASE.—Specimens of native copper from Lake Superior, North America; from Bogolovsk, in Russia (Imp. Min. Inst.); red oxide of copper from Chile and Russia; sulphuret of copper from Cuba, Freiberg, &c.; several varieties of malachite from Russia (Imp. Min. Inst.); blue carbonate of copper from Chile and Russia; copper pyrites from Cuba, Ems, Chile; purple copper ores from Norway and Chile.

Several specimens of partially-smelted copper ores from Valparaiso, imported into Swansea.

The FOURTH CASE is a continuation of the copper ores from Russia and various other parts of the world.

The FIFTH CASE is appropriated to foreign iron ores, among which are magnetic iron ore from Finland (R. Phillips, Esq.); brown oxides of iron from Russia; several specimens of hematite iron from Prussia; red iron-stone of Somorostro, near Bilboa, in Spain, from which is produced the celebrated iron of Biscay.

SPECIMENS OF COAL.

In the central or narrow part of the gallery, forming the west or entrance portion of the apartment now under description, are two horizontal and three upright cases, containing specimens of coal, arranged with reference to their respective locality. In the horizontal cases are specimens of ANTHRACITE COAL from the following places:—Llanelly, Mynydd Mawer, Cwm Glo, Llandybie, Pembrey, Pont-y-Berem, Cwm Ammon, in Caermarthenshire; Cwm Twrch, Aberpergwm, Cwm Neath, Glamorganshire; Bideford, in Devonshire; Saundersfoot, in Pembrokeshire; and from Ystal-y-fera and Abercrave, in Swansea Valley. BITUMINOUS COALS from Sirhowy Iron Works, Monmouthshire, showing the Modelog coal, big-vein coal, and upper-yard coal (the position and depth of these seams of coal are shown by a model in the Mining Records Office); from Herwaun, in Glamorganshire, Dowlais, Merthyr Tydvil, Swansea, and from Pontypool, showing examples of the red vein, meadow vein, rock vein, and horn coal; specimen of peacock coal (so called from its variegated colours) from Merthyr Tydvil.

The upright cases near the entrance contain specimens of coal from various parts of England and Scotland, beginning with the Ell coal, Pyotshaw coal, Main coal, Humph coal, Splint coal, Virtue-well coal, Killogie coal, Drumgray coal, Carlake 1st and 2nd coal, Tower coal, and Cannel coal from Lanarkshire. It is intended, when the series is complete, to have in like manner specimens of the coal produced in the principal working-beds of the several coal-fields of Great Britain. Many specimens, besides those enumerated, have been already received from Newcastle-on-Tyne, Staffordshire, and other parts of the kingdom.

In order to show the detailed and useful nature of the arrangements now being carried into effect, as regards the coal specimens, it may be observed, that the analysis as well as the name and locality will be marked on each specimen, together with a brief epitome of the principal uses and value of each description of coal; and this combination of scientific research and practical observation may, and doubtless will, lead to very useful results in determining the quality of coals best suited for particular purposes. Sections will also be exhibited, in order to show the thickness and mode of deposition of each seam; and contributions of such sections, properly authenticated, will be gladly received from agents and managers of coal-mines. It is preferred that they should be drawn on a scale of one inch to a foot, or one-twelfth of the true size. As an example, the following particulars of a series of sections, by John Buddle, Esq., of Walls-end, are given in a descending order, and they are, moreover, interesting as a description of the principal coal-beds in Northumberland and Durham, from whence the metropolis is supplied :—

Name on the Tyne.	Name on the Wear.	Colliery.	Thickness.	
			ft.	in.
High main	Three-quarter	Percy main	5	9
Yard	High main	Willington	3	0
Bensham	Maudlin	Walls-end	5	4
Six-quarter seam		Ditto	4	1½
Five-quarter	Low main	St. Lawrence	3	2
Low main	Hutton seam	Walker	7	4½
Ruler coal seam		Grand Lease Colliery	2	2
Beaumont or Townley		Ditto	4	7
Ryton stone coal		Ditto	3	3
Ryton, Under, five-quarter seam		Ditto	3	5½
Three-quarter seam, or Ryton yard-seam		Ditto	2	5
Brockwell seam		Ditto	2	8

The specimens of each of the above are on the second shelf, below the Lanark series already named. Each specimen shows in detail a piece of every division of the seam or bed, and also of the bands, foul coal, grey metal, thill, &c., which accompany and divide them; for it may be observed, that a seam or bed of coal is rarely continuous, but consists of separate layers of coals and other substances; hence, when the thickness of a coal seam is spoken of in general terms, it by no means implies that the whole of that thickness is good coal: thus, for instance, the Tyne Low Main or Hutton seam of the river Wear, though called 7 feet 4½ inches thick, contains only 6 feet thickness of coal, and part of that is of inferior quality, as appears by the following section :—

	ft.	in.	ft.	in.
A layer of coal at the top	1	5	1	5
Separation or "parting"	..		..	
Coal	1	1½	1	1½
Band (a thin bed of stone)	0	1	..	
Coal.	2	4	2	4
Parting	..		..	
Coal.	0	11	0	11
Thill	0	1	..	
Coarse coal	0	11	..	
Stone	0	3	..	
Coal	0	3	0	3
	7	4½	6	0½

The High-main seam at Walls-end colliery consisted of—

	ft.	in.	ft.	in.
Good coal.	6	6	6	6
Swad	0	2	..	
Coarse coal	1	4	..	
Very coarse slaty coal	1	2	..	
	9	2	6	6

The Bensham seam in the eastern part of the same colliery is 5 feet 7 inches thick, of which 4 feet 9 inches is good coal; and in the western part it is 6 feet 1 inch, of which only 3 feet 7 inches is good coal; and of 8 feet 6 inches thickness of the Beaumont seam, 4 feet 11 inches only is good coal.

Of the value of such detailed information, more will be said in describing the plans and sections of mines, which come more immediately in the department of the Mining Records Office.

From this general survey of the present contents of the Museum, it is apparent that it furnishes an opportunity of useful study and of practical observation, such as has not yet been established in this country. The accumulation of so great a number of interesting and valuable specimens of ores, building stones, and works of art, &c., in the few years since its commencement, proves at once the utility and popular nature of a museum of this description. Though more immediately adapted to the pursuits of those who are interested either as proprietors or managers of mines, and to architects, builders, agriculturists, &c., yet such is the beauty of many of the specimens, and so plain and intelligible are the descriptions which accompany them, that there is little doubt of this museum becoming ere long a place of frequent resort to all who are desirous at once to gratify the eye and to acquire useful knowledge in the various departments of art and science which are so admirably illustrated by this collection. By the liberality of government, its doors are thrown open to the public, in order that all may see and learn what all are more or less interested in, namely,—THE APPLICATION OF THE NATIVE RICHES OF OUR SOIL TO THE COMFORTS AND ELEGANCIES OF DOMESTIC LIFE, AS WELL AS TO THE IMPROVEMENT AND EXTENSION OF OUR COMMERCE, AGRICULTURE, AND THE USEFUL AND FINE ARTS; all which eminently depend on a right appreciation of, and due attention to, the practical results of the study of ECONOMIC GEOLOGY.

MINING RECORDS OFFICE.

INTRODUCTORY OBSERVATIONS.

This Establishment is immediately adjacent to, and closely connected with, the Museum of Economic Geology. Many of its contents are of such a nature as to preclude an indiscriminate admission, which indeed would in a great measure defeat the object of its becoming a place of study and of leisurely examination by those who are more immediately interested in the management of mines, or in the attainment of a general knowledge of mineral districts. The admission to this department is, therefore, subject to such regulations of the Director as may from time to time be found expedient, and be approved by government; the express object of such regulations being to afford the greatest amount of accommodation that is consistent with the examination of plans, models, and explanatory documents. These regulations will be exhibited in the lobby or entrance to the Museum of Economic Geology, and applications to Mr. T. B. Jordan, the keeper of Mining Records, will at all times receive prompt attention.

At the Newcastle Meeting of the British Association, in 1838, the importance of preserving mining records was submitted in a communication entitled, 'Suggestions on the Practicability and Importance of preserving National Mining Records, by Thomas Sopwith, F.G.S.' (Rep. Brit. Association, vol. vii., p. 156.) The following extracts from this paper may serve to point out some of those general views which render the subject of national interest, and which, by the instrumentality of the British Association, and the zealous advocacy and strong recommendation of Sir H. De la Beche, have been reduced to practice in the Office of Mining Records now to be described.

"That the prosperity of Great Britain depends mainly on its MINERAL PRODUCTIONS, is too obvious to require comment. It follows from thence, that whatever tends to promote economy in mines, and to afford increased facilities for obtaining their products, is deserving of the attention of every one who would secure the future as well as the present welfare of the country.

"Of the great value of, and the necessity which exists for, a regular system of preserving mining records, so much has been said by the most eminent and experienced geologists and miners, that it requires some apology for again adverting to it: that apology, however, is best made by mentioning the fact, that hitherto no regular or extensive system of preserving mining plans has yet been adopted in this kingdom, It may not, therefore, be entirely without its use to solicit the attention of the British Association to a matter so closely connected with the interests of science as well as commerce, and indeed with the welfare of the community at large; nor, if the subject be deemed worthy of attention, could it be more appropriately brought before the society than during its meeting in the midst of the mining districts of the North of England.

"In order to show in how strong a manner the opinions of the best-informed miners have been expressed, I shall briefly state the substance of the remarks made on this subject by the celebrated Werner; and as regards the coal and lead mine districts in the North of England, I shall give the opinions of Mr. Taylor and Mr. Buddle, than whom no persons are more competent to form a correct judgment on the value and importance of preserving mining records.

"Werner, in his theory of mineral veins, describes the manner in which mining plans should be constructed, and comments on the advantage of having such plans and geognostic descriptions of every mining district. 'Such a collection,' he observes, 'the *plan* and *description* of the district, form together a complete and instructive whole. If our ancestors had left us such documents for two centuries past, or even for half a century, what advantage would it not have been to us? From what doubts would it not relieve us? With what anxiety do we not turn over the leaves of ancient chronicles in search of information often very imperfect, obscure, and uncertain? With what pleasure do we not receive the least sketch or plan of some ancient mine? With what pains do we not rake up the old heaps of rubbish brought out of old excavations to find pieces which may afford us some idea of the substances formerly worked in them? Yet between these documents and those which we might obtain in the way pointed out, there is as much difference as between night and day. Is it not an obligation, a duty, for us to collect and leave to future generations as much instruction and knowledge as possible on the labours carried on in our mines, whether it be in those that are still worked, or in those which have been given up?"

"Such was the opinion of this great geologist, whose knowledge of practical mining adds great weight to his recommendation.

"Mr. Taylor, in reporting on the lead-mines of Alston Moor, which are placed under his superintendence, states, that he considers it 'of great importance that perfect records of what has been done in the pursuit of every vein on the estate should be preserved; and I would recommend for this purpose, that in all future leases a clause should be introduced to require the adventurers to keep SECTIONS and PLANS of all their workings;' and as regards the coal-mines of Northumberland and Durham, the following remarks by Mr. Buddle are equally conclusive as to the necessity which exists for improved methods of preserving mining records. 'It is obvious,' he states, 'that many collieries which are now open will sooner or later be shut up, and lie dormant for various and indefinite periods; and the probability is, that in many cases all knowledge of the dykes which intersect them may be lost, and that the parties having to re-open them may be as ignorant or even more so than those who first opened them. It is not necessary,' he continues, 'that I should dwell on the extent of the LOSS OF PROPERTY AND OF LIVES which may result from such a state of things;' and adds, that although the several dykes which have been met with are accurately represented on the working plans of the several collieries, yet, 'from the detached and local nature of these plans, no general and accurate notion of their lines of direction, bendings, and throws, can be formed from such detached sources of information.'

"It is not, however, so much with reference to particular mines or mining districts, as to a general and national system of preserving Mining Records, that I submit these observations to the scientific body now assembled at Newcastle. The advantages of preserving such records partake as largely of national benefit as of private interest to the owners of landed property. The former of these is under the guidance of the statesman, but no means have yet been devised by which individual enterprize could be directed to such an object. The circumstance of most mines being held only for a limited term of years naturally occasions an indifference to the future state of the workings, and even the owners of mines too often confine their attention to a limited prospect. Many persons are altogether insensible to the nature of the advantages proposed to be gained by preserving accurate mining records, nor can private individuals effect that careful and permanent preservation, or afford the inspection to others, which could only be accomplished by a public institution. Of the necessity for mining records there can be little doubt in the minds of those who know how immediately the national welfare depends on the mineral products, and how very much the obtaining of these products depends on an accurate knowledge of what has previously been done, especially in mines which have been long abandoned. The authorities above quoted form as strong a testimony as the best mining experience can furnish—the general merits of the question are such as can be well appreciated by scientific and practical men. If the importance and practicability of a national system of preserving mining records should be admitted, there are few more definite objects (combining, as it does, general science and national usefulness) for the British Association to promote than this, of obtaining the aid of the legislature and the support of the large mine-owners to a REGULAR, SYSTEMATIC, AND PERMANENT RECORD OF THE MINING OPERATIONS AND MOST IMPORTANT GEOLOGICAL PHENOMENA OF THESE KINGDOMS."

The following is a minute of resolutions passed by the Council of the British Association at the meeting at Newcastle, August 25, 1838. (Vol. VII. p. xxiii.)

"Resolved,—1. That it is the opinion of this meeting, that with a view to prevent the loss of life and of property which must inevitably ensue from the want of accurate mining records, it is a matter of national importance that a depository should be established for preserving such records of subterranean operations in collieries, and other mining districts.

"2. That a committee be appointed to draw up a memorial, and to communicate with the Government, in the name of the British Association, respecting the most effectual manner of carrying the above resolution into effect.

"3. That the committee consist of the following gentlemen, with power to add to their number:—The Marquis of Northampton, Sir Charles Lemon, Bart., M.P., Sir Philip Egerton, Bart., John Vivian, Esq., Davies G. Gilbert, Esq., J. S. Enys, Esq., W. L. Dilwyn, Esq., Charles Lyell, Esq.; the President for the time being of the Geological Society of London; the Professors of Geology in the Universities of Oxford, Cambridge, London, and Durham; H. T. De la Beche, Esq., John Taylor, Esq., John Buddle, Esq., Thomas Sopwith, Esq."

In pursuance of these resolutions a meeting was held at the office of Mr. Sopwith, in the Royal Arcade, Newcastle, on the 27th August,—Present, Sir Charles Lemon, Bart. M.P., in the chair, the Rev. Dr. Buckland, the Rev. Professor Sedgwick, Professor Phillips, Professor Johnston—John Buddle, Richard Griffiths, and Thomas Sopwith, Esqs., when the following memorial was drawn up.

"To the Right Honourable the Lords of Her Majesty's Treasury, &c.

The Memorial of THE COMMITTEE FOR THE PRESERVATION OF MINING RECORDS appointed by the BRITISH ASSOCIATION FOR THE PROMOTION OF SCIENCE, assembled at Newcastle, August 25, 1838.

Humbly Showeth,

That whereas it has been made apparent to your Memorialists, that great loss of life and destruction of property have resulted from the imperfect preservation of Mining Records; and whereas still greater losses will inevitably ensue unless advantage be taken of the experience of living individuals, who are willing to place in any Public Depository that may be provided, copies of the numerous mining documents now in their possession:

And whereas the preservation and economical use of mineral produce, and especially of coal, are of great importance not only to the proprietors of mines, but to the nation at large:

Your Memorialists feel it to be their duty respectfully and earnestly to call your Lordships' attention to the expediency of establishing, as soon as possible, a national depository for the preservation of documents recording the mining operations of the United Kingdom.

That the experience of the neighbourhood of Newcastle, within the personal knowledge of several of your Memorialists, affords appalling examples of the loss of life and waste of highly valuable mineral property, which would never have occurred had such documents been preserved as it is now the object of your Memorialists to collect. As, in the lapse of time, mining operations become of necessity more complicated and dangerous, and the risk of the recurrence of similar catastrophes will be continually increasing, it appears to your Memorialists that the only sure and effectual means of preventing these deplorable results is the establishment of such a public office as has already been alluded to.

The practicability of carrying out the above measures has been shown by what has recently been done under the direction of the Board of Woods and Forests, in the case of the coal-mines in the Forest of Dean, and by the documents relating to the coal-mines of Newcastle, which have been deposited by Mr. Buddle in the archives of the Natural History Society of Newcastle. It is within the knowledge of your Memorialists that an immense number of similar documents are in the possession of individuals who are now willing to place copies of them in any public depository under the control of Government.

Your Memorialists therefore humbly pray that your Lordships will be pleased to take the premises into your consideration.

(Signed) CHARLES LEMON,
Chairman."

This representation to the Government, followed up by the zealous advocacy of the Marquis of Northampton and Sir Henry De la Beche, led to the arrangements which are now being carried into effect; and at a meeting of the Mining Records Committee in March 1839, it was considered that no place of deposit could be more suitable than one in connection with the Museum of Economic Geology. On the recommendation of Sir H. De la Beche, Mr. T. B. Jordan was appointed keeper of Mining Records on Oct. 10, 1840 (see p. 3); in virtue of which appointment the several plans, sections, implements, and models appertaining to this department, are placed under his care.

The following notices of the Mining Records Office appear in the published addresses of Dr. Buckland as President of the Geological Society, 1840 and 1841.

" To the keeper of these records will be assigned the duty of arranging the documents which may be transmitted to him from all parts of the kingdom, by any engineers, mineral surveyors, and proprietors of mines and coal works, who may be willing to send them; particularly maps, sections, and under-ground plans, which will record the state of each mine, when it is abandoned, for the information of those who, at a future period, may be disposed to bring it again into operation. This office will be accessible to all persons interested in obtaining the information it will afford. To this collection several engineers of most extensive experience in the mines of Newcastle and Cornwall have promised large contributions.

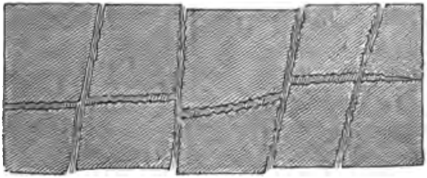
" The keeper will make copies of documents of this kind, which proprietors of mines who cannot conveniently part with the originals may lend, for the purpose of being preserved in this national collection."—*Annual Address, Feb.* 20, 1840.

"Here will be also large collections of models illustrative of machinery used in mines, as well foreign as British; so that not only will the British miner be enabled to compare the machinery employed in different parts of his own country, but he will also find that adopted in foreign countries. It is understood that any one desirous of making drawings of these models, for the purpose of erecting machinery from them, will be permitted to do so under proper regulations.

"In addition to this collection of models of mining machinery, there will be other models illustrating the mode of working mines in different localities. A very beautiful model of the celebrated Dolcoath mine in Cornwall is now in the collection; and we understand that Mr. Sopwith is preparing for this museum models of the coal-fields of the Forest of Dean, and of Northumberland and Durham. Models illustrating the mode of working coal, and of ventilating the collieries in the North of England, are also in preparation. From all these the public may receive VALUABLE, CONDENSED, and GRATUITOUS INFORMATION as to the mode of the OCCURRENCE OF MINERALS within the earth, the various methods of WORKING MINES, and the MACHINERY by which coal and metallic ores are brought to the surface and fitted for the market. There will be also models illustrating the metallurgic processes, and samples of the various stages of these processes, and their final results.

"The agriculturists are availing themselves of the facilities afforded by the laboratory, and analyses of soils have become numerous. It is in contemplation, also, to have lectures on various branches of economic geology, including building materials, agricultural chemistry, geology, mineral analysis, and metallurgy." —*Annual Address*, *Feb.* 12, 1841.

The preceding notices have been introduced in considerable detail in order to show that the establishment which government has commenced was based on solid grounds, and sanctioned by the highest scientific authorities, as well as called for by the urgent necessities of the case. Much has already been done, but much also remains to be done; and hence it cannot be too frequently or too earnestly impressed on public attention, that our greatness as a nation wholly depends on the prudent economy of our mineral wealth. Without diligent attention to this subject, the eloquent declamations of Werner may ere long be again poured forth by the witnesses of the rapid declension and unavoidable decay which must ensue if accurate records of subterranean operations are not preserved in the manner and for the objects briefly indicated in the preceding pages.



DISLOCATION OF MINERAL VEINS.

MINING RECORDS OFFICE.

The apartments of this Establishment immediately adjoin those of the Museum of Economic Geology, as already described in p. 9; and the several collections now in progress may be classed under the following heads, which will be described in succession, accompanied with such general explanatory notices as may elucidate the utility, and tend to promote a popular understanding, of the advantages to be derived from each department.

I. MODELS OF MINES AND MINERAL DISTRICTS.

II. IMPLEMENTS AND MATERIALS USED IN WORKING MINES.

III. MODELS OF MACHINERY FOR PUMPING WATER FROM MINES, RAISING MINERALS, AND FACILITATING THE DESCENT AND ASCENT OF MINERS.

IV. MODELS OF MACHINERY AND APPARATUS FOR WASHING AND DRESSING ORES, AND OF FURNACES, MILLS, &c., IN WHICH ORES ARE SMELTED AND CONVERTED INTO FORMS SUITABLE FOR COMMERCIAL AND MANUFACTURING PURPOSES.

V. MODELS ILLUSTRATIVE OF SUCH GEOLOGICAL PHENOMENA AS ARE IMPORTANT TO BE STUDIED IN CONNECTION WITH PRACTICAL MINING AND THE EXPLORATION OF MINERAL DISTRICTS.

VI. PLANS AND SECTIONS OF MINES AND MINERAL DISTRICTS.

VII. RAILWAY SECTIONS, ILLUSTRATING THE GEOLOGY OF THE DISTRICTS PASSED THROUGH.

VIII. INSTRUMENTS USED FOR SURVEYING, LEVELLING, AND DELINEATING PLANS, SECTIONS, AND ISOMETRICAL DRAWINGS OF MINES.

In the preceding arrangement, it may be observed that especial reference is had to the advancement of practical mining and metallurgy, and to such geological features as are important to be known in connection with mining. Models affording the nearest resemblance to nature are placed first, as being analogous to the study of the mines and mineral districts which they respectively illustrate. Then follow specimens of the actual implements used in working mines, so that a miner from Cornwall or Devon may at once see the implements used by miners in Durham, Cumberland, or Scotland, or by continental miners. Next are shown the various means of extracting water and minerals from the interior of the earth, followed by explanations of the washing, dressing, and smelting of ores, all which processes are illustrated by models of the machinery used for draining mines, and of the furnaces, mills, &c., in which ores are smelted and rendered available for the uses to which they are to be applied. So much of the science of geology as has a direct bearing on the working of mines, and the exploring of mineral districts, is exhibited and explained in the fifth class, and this department will afford a large amount of popular information on the subject of the geological structure of mining districts. Plans, sections, and isometrical drawings of mines and sections of railways, follow in the sixth and seventh classes; and by the eighth class it is intended to afford useful instructions to surveyors and mining agents as to the best description and useful application of instruments in preparing scientific plans and records of subterranean works.

MODELS OF MINES AND MINERAL DISTRICTS.

"Next to the actual inspection of any object, a model is the most perfect means of conveying a clear idea of the general appearance and construction of the object which it represents; and in some cases a model exhibits and explains details which either cannot be grasped at once by the eye in the real object, or which are hidden from actual inspection, as in the case of the geological structure of the earth, or the interior of mines."—*On the construction of Geological Models, by T. Sopwith. Report of British Association*, 1838.

1. **Model of Dolcoath Mine, by Mr. T. B. Jordan**, Keeper of Mining Records.—This model occupies a recess at the east end of the Upper Gallery or Model Room. It affords a perfect view of the general arrangements of an extensive tin and copper mine, and was constructed by Mr. Jordan, when residing at Falmouth, in 1839. It measures in length 5 feet 9 inches, and is 2 feet 5 inches high; each inch represents 8 fathoms or 48 feet; and as a scale of comparison it may be observed that the Monument of London is about 200 feet high, and therefore would be represented by a small cylinder 4 inches long; the depth of this mine is therefore more than seven times the height of the Monument, and the descent to this vast depth is almost universally effected by means of ladders, some of which are shown in the model. Those parts of the model which are formed of mahogany represent the *granite* which, in some parts, forms the walls, sides, or *cheeks* of the lode or mineral vein, the remaining portion being *killas* or clay-slate, represented by white wood (plane-tree or sycamore). As these descriptions are intended to convey informa-

tion to those who are not conversant with mining details, as well as those who are, it may be useful to observe, that *lodes* or mineral veins are analogous to nearly vertical cracks or fissures, and thus widely differ from coal mines, where the *seam* or bed of coal lies nearly horizontal, or inclined at an angle which seldom exceeds 10 or 15 degrees; whereas mineral veins, *i. e.* containing tin, copper, lead, &c., rarely exceed that amount of divergence from a perpendicular, subject however to various undulations, as a glance at this model will at once show. The contents of the crack or fissure called the LODE (which, in this instance, is the main or principal lode, there being many such lodes running in nearly parallel directions, as shown by the plan of the mine) are represented by ebony or black wood, varying so as to represent a thickness from 2 to 6 feet. Considerable portions of this lode are seen to have been excavated, partly by regular shafts and drifts, and partly by extensive workings of irregular shape, depending on the productiveness of the lode. Some of these excavations are filled up again, whilst others are left open, as shown in the model. It will therefore be understood that the granite and clay-slate rocks are entirely removed from the side next the spectator; a view of the lode and the workings is thus obtained, and the unfilled excavations afford a view of the solid rocks on the further side of the lode, where the observer may trace the junction and intermixture of these rocks, the granite being as it were in some places injected into the substance of the killas.

On the surface, beginning at the left-hand side of the model, are *deads*, or heaps of refuse, brought out of the mine. In a small valley are *dressing-floors*, with *stamps* worked by a large water-wheel. In front is a steam-engine working a *whim*, a rope from which communicates with and draws the ore, &c., from a shaft in a lode which runs at a short distance nearly parallel to that represented by the model. Two small houses on the right of this valley are called *burning-houses*, where the ores of copper and tin are roasted, and afterwards separated on the adjoining floors, as shown by the different heaps.

A series of five water-wheels works sets of stamps contained in adjoining sheds. The stream of water for these wheels is partly pumped from the mine and partly derived from other sources. The small round heaps represent copper ore ready for the market.

In the centre of the model is the pumping engine by which the mine is drained; the water is pumped up to within 10 fathoms of the surface, and escapes by the *adit* or *adit-level* nearest the surface. In front are the coal yard and smithery. Behind, and on the right of the engine, are sheds where women are employed to break the ore, and an adjoining reservoir contains water for dressing the ores. The railroads shown by double lines are in some places carried under the buildings in tunnels, and in others pass over a framework where the ores are deposited; at the end of which is a *crushing machine* worked by water. At the extreme right of the model the railway from Hayle to Tresavean passes obliquely across a corner of the model.

Three steam-engines are employed to draw ores from three shafts in the main lode, as shown on the model. It would require a volume to describe fully the several processes carried on in the buildings and other places thus briefly enumerated; but the general idea of them afforded by the model is in miniature what a stranger would observe on a view of the establishment, with this advantage, that while the model gives a bird's-eye view of the general arrangement, other models, yet to be described, may be seen in the gallery, by which the exact nature of the stamping and dressing ores, &c., may be readily understood. As regards the interior, also, the eye at once comprehends the entire workings of the main *lode;* and the mind thus acquires a conception of all the arrangements, which could not be obtained by visiting in succession a few of the principal galleries or workings of the mine. The construction of the pumps, and the method of raising the ores, are explained by large separate models; and every variety of the ores, their mode of occurrence, and specimens of the associated rocks, are contained in the Museum of Economic Geology. The length of the *lode* represented is 3312 feet (not quite two-thirds of a mile, or 3520 feet); the depth of the main shaft is nearly 240 fathoms (1440 feet). In 1815, the copper ores obtained at this mine produced 66,839*l.*, the greatest amount in that year of any mine in Cornwall;* and in a valuable statistical account by Sir Charles Lemon, of the number of persons employed in the Cornish mines in 1836 and 1837, it appears that 300 men, 220 women, and 70 children, making a total of 590 persons, were employed at this mine.

2. MODEL OF WHEAL JEWEL, BY ROBERT WERE Fox, Esq., of Falmouth.—This small but ingenious

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* For further details of this mine, and of the district in which it is situated, see De la Beche's Geological Report on Cornwall, Devon, and West Somerset, containing an engraved plan and section of this mine, and much valuable scientific and statistical information on all matters relating to the mines of these counties.

and instructive skeleton-model is made of card-board on a scale of 20 fathoms (120 feet) to an inch. Its dimensions are 21 inches long, 8 inches wide, and 7 high. The *granite* rocks are represented by *yellow* colour, and the *killas* or clay-slate is *white*. The parts coloured *green* show where *sulphuret of copper* or *grey ore* has been obtained; a *yellowish-green* indicates *copper pyrites*, and a *red* colour shows where *tin* ore has been found. The *shafts* and *levels* are represented by black lines, distinguishing those which are used for ascending and descending by ladders.

The *cross-cuts* or galleries which extend from one lode to another are shown by wires connecting them. The *cross-courses** are represented by strings crossing the model obliquely; and the amount of dislocation of the lodes produced by them is rendered apparent by a corresponding bending of the card-board. Small moveable tickets attached to different parts of the lode show the number of *workmen* in black figures, and of *boys* in red figures.

At the extremity of the levels is marked the price per fathom paid for driving, called *tut-work*, which of course varies with the hardness of the rock; thus, for instance, at the end of the *ninety-fathom level* 8*l*. 10*s*. per fathom was paid, while the *hundred-fathom level* cost 10*l*.; but in other parts the latter cost 12*l*., and even 14*l*. per fathom. The length of level driven each month is shown by a small mark, by which a person not conversant with mining may appreciate how slow a progress is made in effecting these vast subterranean works; and it follows that the price increases as the length driven in a month diminishes. In the coloured parts of the model, where ore has been obtained, small figures show how much for each pound sterling value of ore obtained the workmen (called tributers) receive for their labour. This interesting little model, therefore, not only exhibits a correct view of the geological conditions, but serves also as an explanatory index to the working statistics of the mine, and accomplishes the object which the author of these notices desired to promote in another part of the kingdom, by the publication of geological sections of mines* in 1829. Mr. Fox, who constructed this model, is the author of 'Observations on Mineral Veins,' published in the Report of the Royal Cornwall Polytechnic Society in 1836; and the mining student is strongly recommended to refer to it, as well as to the geological report of Sir H. De la Beche, which Mr. Fox designates as "the most important document as it respects the phenomena of mineral veins which has hitherto appeared."

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* For an illustration of the mode of occurrence of these and other mineral veins, see Model No. 13 of Class V.; and for detailed information, see De la Beche's Geological Report on Cornwall, &c., p. 283.

3. MODEL OF A NEWCASTLE COAL MINE, ILLUSTRATING MR. BUDDLE'S SYSTEM OF DOUBLE OR COMPOUND VENTILATION OF FIERY COLLIERIES, BY W. OLIVER,

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* "Although shareholders (of mines) must necessarily place great reliance on the skill and integrity of their resident agents, and cannot, from occasional opportunities, acquire the knowledge of mining affairs requisite for the immediate direction of them, yet, in conducting such extensive speculations, it is highly desirable that the operations should be as far as possible made intelligible to all who take any interest in them. Such a general knowledge as would enable them to understand the nature of the works and the objects contemplated in any suggested undertaking would be much more satisfactory than the entire dependence on others, induced by the want of means to form an opinion for themselves."—*Geological Sections of Mines. T. Sopwith.* 1828.

WALLS-END, MARCH, 1840.—This model is 3½ feet long and 2½ feet wide, and was made under the immediate superintendence of Mr. Buddle for this museum, on a scale of 11 fathoms (66 feet), or 1 chain to an inch. It represents a *seam* or bed of coal of the ordinary thickness, lying in the nearly horizontal position which prevails in the coal districts near Newcastle; and thrown down on one side by a *downcast, trouble, or fault* (analogous to the lodes or mineral veins in which tin, copper, and lead are found; but instead of being, as in the latter case, the depository of mineral riches, such dislocations interrupt the coal miner,—and hence the above expressive and dolorous names). The Walls-end colliery near Newcastle (so called from its being situated at the eastern terminus of the Roman wall, which stretched nearly across the island) occupies about 1250 acres, and has been extensively wrought under the direction of Mr. Buddle. The model shows an area of about 126 acres. The *High Main* seam or bed of coal in this colliery varied in thickness from 6 to 9 feet, and the average of clear marketable coal was about 6½ feet. In 1810, Mr. Buddle established the system of double ventilation, which it is the object of this model to illustrate. It consists in dividing the principal current of air at the bottom of the downcast shaft (marked A on the model), or in any part of the workings, into two or more currents;* which currents may be carried separately through different divisions of the workings, and discharged by separate passages into the upcast shaft marked B. A furnace at C rarefies the air in the upcast shaft so as to induce a strong current of air from the other drifts which have no furnaces; and the inflammable air is carried by a drift into the shaft without coming in contact with the flame. The direction of the currents of air is shown by small darts passing along the galleries of the mine, and further particulars of their mode of transit are explained by a printed reference on the model. The regular method of working, by leaving pillars to support the roof or incumbent strata, is admirably shown by this model, which affords an excellent idea of the interior of a coal-mine.*

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* This system is carried to its highest perfection by Dr. Reid in the arrangements for ventilating the Houses of Parliament; and the lofty brick chimney erected a few years ago is analogous to the *upcast* shaft of a coal mine, and like it has a furnace at the bottom. A shaft in the Victoria tower will form the *downcast* pit for the supply of pure air to the new Houses.

4. Model of Her Majesty's Forest of Dean, in the County of Gloucester, by T. Sopwith, F.G.S.—This model was made in 1837 for the Commissioners of Woods and Forests, by whom it was deposited in the Mining Records Office. It is 30 inches square, and represents a tract of country comprising the principal coal-field of Dean Forest, six miles from north to south, and the same distance from east to west,—the superficial area, therefore, being 36 square miles, or 23,040 acres. It is divided into 36 squares by parallel lines 5 inches apart, each compartment representing one square mile, and forming a convenient means of reference to a book wherein all the names of places, pits, strata, &c., are described,

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* For further details of colliery ventilation and mode of working, see 'Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne,' vol. ii.—*Mr. Buddle on Mining Records*, p. 309.

both numerically and alphabetically. Various colours represent planted enclosures belonging to the crown, roads, reservoirs, &c. Railways are shown by black lines, streams of water by blue lines, and buildings by a bright red colour. The *outcrop* or basseting of the principal beds of coal is shown on the surface, and vertical sections of the strata are painted on the sides of the model. These comprise the *coal measures* or strata,—the seams of coal being represented by black lines; below these are the strata of the carboniferous or mountain limestone, resting on the old red sandstone which forms the base of the models, and is at least from 6000 to 8000 feet in thickness. In order to show similar vertical sections in the interior of the forest, the model is made in four compartments, which are placed on a sliding table so as to be easily separated, and thus exhibit a section across the middle of the coal-field, from north to south and east to west. The upper surface of the model, or face of the country, is made to lift off, in order to show the position and extent of the *Park End* or *Lowery Vein* of coal. This may be again lifted up to show the workings in the Bilson quarter; and by a third removal a view is obtained of the *Coleford High Delf Vein*, which, although the lowest in geological position, is, by its cropping out on high ground, worked by means of free levels; that is to say, by horizontal drifts from the surface in Bixslade and other valleys; whereas the Lowery coal, which, in geological sequence, lies far above it, can only be worked by means of deep pits; and this apparent anomaly will at once appear on examining the two veins of coal on the model. The thickness of the coal seams varies from 2 to 6 feet; but the thickness of good workable coal rarely exceeds 4 feet. The vertical scale of this model is enlarged three times, by which means the undulations of the country are rendered more prominent, and a greater space is obtained for inserting the details of the section. This enlargement of the vertical scale gives to the eye the same fallacious aspect that is presented to our sight in travelling over a country; but in a scientific point of view the natural scale (see Model, No. 5) has a decided advantage, being based on geometrical truth, and conveying an exact knowledge of the *real*, not the *apparent*, relations of the surfaces and other objects represented. The method of constructing models of this kind was first exhibited and explained in 1838 to the mechanical section of the British Association; and formed also the subject of communications to the Institution of Civil Engineers in 1840 and 1841, for which, in the latter year, a Telford medal in silver was awarded to the author. The surveys from which this model was constructed were previously made by T. Sopwith; and the additional cost of the model, which was made at his offices in Newcastle, did not amount to a *penny an acre.*

5. LARGE MODEL OF THE FOREST OF DEAN, BY T. SOPWITH, F.G.S.—This model is on double the scale of the last mentioned, viz., 10 inches to a mile, or 8 chains (176 yards) to 1 inch. Those who have visited the bold picturesque scenery, the deep valleys, lofty hills, and steep roads of the Forest of Dean, will scarcely recognize in this model an exact fac-simile of its surface. This, however, is easily accounted for when we consider how much objects are fore-shortened as regards distance, whilst their full

height is seen; and hence it is only from an elevation of a few miles, as if seen from a balloon, that the true relations of length and height of the surface can be duly appreciated. In looking at the model, the eye is raised in proportion to the scale a height corresponding from 1 to 2 miles (represented by 10 or 20 inches); and hence an instructive lesson is afforded of the comparative flatness of even a hilly district. This model may be separated in six compartments; and the general description of the surface and strata of No. 4 applies to this. The lines which divide the surface into square miles are repeated on the beds of coal, on which also are lines of equal altitude, at vertical distances of 100 yards; from which it is apparent, that a pit of 50 fathoms in depth would, in one part of the bed of coal, drain only a narrow strip, and in another a very broad portion. Some of the principal workings or collieries are shown by different colours on the beds of coal; but these details, and the position and extent of each tract of coal, will be best understood by referring to the map of the forest, which is placed on an adjacent wall. These and similar models exhibited at meetings of the British Association, the Geological Society of London, and at the soirées of the Presidents of the Royal and Geological Societies, have been honoured with the approval of many of the most eminent scientific and practical men; and the following favourable notice of mining models by Sir Henry De la Beche, in a report to government, appears in the estimates for miscellaneous services in the year ending 31st March, 1843.

"The model department, which continues to receive the support and assistance of miners and engineers, has been considerably increased during the year. Among the various models added to the collection, one of the Forest of Dean, executed upon a new plan by Mr. Sopwith, civil engineer and mineral surveyor, would appear to merit marked notice, as it so well shows the mode in which coal-beds occur beneath the surface in that and in other coal countries: it represents an area of 24 square miles, and exhibits the succession of the various rocks with which the coal is associated, while the natural and artificial character of the surface is properly exhibited: by a very ingenious mode of construction, this model can be dissected so as to exhibit the mode in which the chief coal-beds occur beneath, the scale for height and distance being equal. Models of this class constitute a miniature representation of nature; and, if faithfully constructed, and the workings, if any, correctly marked, they cannot fail to be of great value in mineral districts. Being more generally instructive than plans and sections for illustration, it is intended to have some chief points in our various coal countries modelled in this manner; and it is hoped, by their accumulation, the model collection may afford important aid to the British miner and coal proprietor.

" Another model added to the collection during the year, and deserving particular notice, as properly diffused knowledge respecting the subject it illustrates may tend to the saving of valuable life and property, is one of a Newcastle coal-mine, illustrative of Mr. Buddle's system of the double and compound ventilation of fiery collieries. Regarding the models in the collection generally, it is intended, that while, on the one hand, due attention should be paid to all the improvements of the day; on the other, the simpler forms of machinery employed in infant mining operations should not be neglected, so that a knowledge of the latter may be rendered available to our colonists."

A duplicate model of the Model No. 4 is placed in the Ashmolean Museum at Oxford, and a duplicate of No. 5 in the Woodwardian Museum at Cambridge, where they are used as illustrations during the lectures of the distinguished professors of geology at these universities. They have also, as regards the details of construction, as well as the geological and mining features, been exhibited and explained by the author to the engineering students of the University of Durham, the Geological Societies of Manchester and the West Riding of Yorkshire, and to the Philosophical Societies of Newcastle and Leeds.

6. MODEL OF EBBW VALE AND SIRHOWY IRON WORKS, IN THE COUNTY OF MONMOUTH, BY T. SOPWITH, F.G.S. —This model comprises nearly four square miles of ground. It is constructed on similar principles to those already described, and is divided into four compartments. The surface of the country is accurately represented, the vertical and horizontal scales being alike, viz., six chains, or 132 yards to an inch. The upper surface being taken off, the *Black-pins Mine*, a vein of ironstone with the workings in it, appear. Below this, the *Three-quarter Coal*, *Modellwg Coal*, and *Red-vein Mine*, are all exhibited by removing the successive trays which represent the intervening strata. The outcrops of the strata forming a circuitous bend round the hill, and the V-like forms pointing down the valley, are worthy of observation; and the favourable

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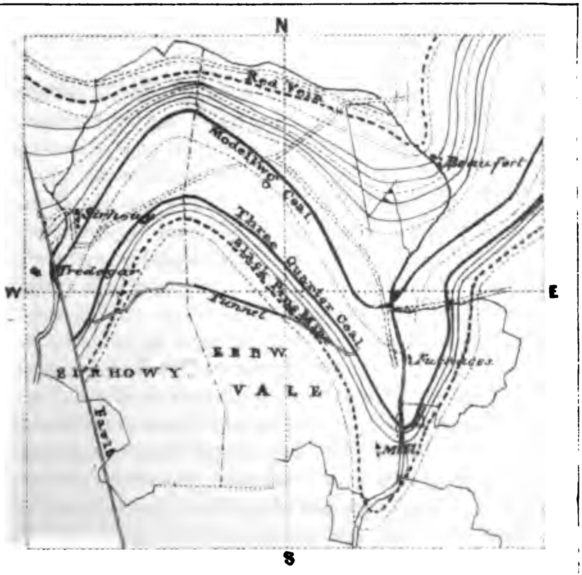

PLAN OF EBBW VALE AND SIRHOWY.

Scale of Miles.

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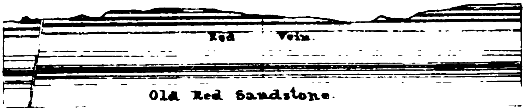
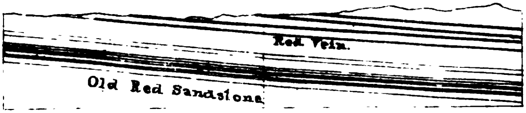
SECTION FROM WEST TO EAST.



SECTION FROM NORTH TO SOUTH.



position of these vast and rich deposits of coal and ironstone may be more readily understood by a brief inspection than by volumes of description. Exclusive of the surveys and levelling, most of which had been previously done, the construction of this model cost nearly 4*d.* per acre, the superficial area or scale being seven times larger than that of the model of Dean Forest, No. 4.

7. MODEL OF PART OF THE LEAD MINING DISTRICT OF ALSTON MOOR, IN THE COUNTY OF CUMBERLAND, BY T. SOPWITH, F.G.S.—The manor of Alston Moor, belonging to the Commissioners of Greenwich Hospital, was surveyed upwards of two hundred years ago, and its mines were reported to be nearly exhausted; in consequence of which the *manorial rights,* 120 acres of land, several houses, a corn-mill, &c., were sold for 2500*l.* In 1821, Mr. Locker, then secretary, and subsequently a Commissioner of Greenwich Hospital, reported this estate as being "*the most valuable and interesting part of the landed property of Greenwich Hospital,*" the mines then yielding an annual produce of 100,000*l.*, nearly one-fifth of which was received as rent or royalty from the mines. The strata of this district consist entirely of the mountain or carboniferous limestone, which are nearly horizontal, rising very gradually to the west, and extend with surprising regularity over a great extent of country, forming the mining districts of Alston, Allendale, Whitfield, Weardale, Teesdale, &c. This model represents part of the central and rich mining district adjoining the river Nent, and exhibits the thickness and inclination of the strata of limestones, hazles (or sandstones), and argil-

laceous beds; in the front or lower side of the model, the great aqueduct, called the "Nent-force Level," is shown. This work was projected, in 1775, by Mr. Smeaton, the celebrated engineer (at that time one of the receivers of these estates), and its judicious execution gave a powerful impulse to those exertions of private adventure which have in many instances proved so advantageous to all parties, and especially to the Commissioners of Greenwich Hospital. Nentsberry engine-shaft, represented on the model, is sunk down to Nent-force Level, 3½ miles from the entrance. The whole of this distance, which was then navigable in boats, was surveyed by the author in 1826. It has since been continued, as shown in the model, on the top of the stratum of limestone called the *scar limestone.*

The usual mode of entrance to the lead-mines of Alston is by means of adits, or water-levels, made sufficiently large for a horse to travel in. The entrance, or *level*-mouth, as it is called, of Nentsberry-greens Mine, is shown on the model, and the several *rises* or shafts by which access is gained to the vein of ore in the GREAT LIMESTONE. The veins of lead ore are similar in their nature to the lodes described in page 63; but in the Cornish lodes it may be observed, in Mr. Jordan's model, No. 1, that the sides, walls, or *cheeks* of the lode, are formed either of *granite* or *killas*; but in the model now before us, it appears that the sides or cheeks of a *lead vein* in stratified rocks are formed, as it were, of a succession of narrow stripes or layers of strata. Now a vein may be popularly described as a *crack*, descending in a nearly vertical direction through these various laminæ; and it usually happens that the strata have not only been separated a few inches or a few feet (forming the thickness of the vein, and subsequently filled with *vein-stone*, *rider*, *galena*, or lead ore, &c.), but also that a vertical shift has taken place, by which means the strata, which were formerly continuous, are no longer opposite each other, but considerably removed. Hence the side of a vein may be limestone on one side and sandstone on the other, or sandstone and clay may be opposite; but it is when limestone forms both *cheeks* or sides that veins are usually most productive. It may be seen that *Old Carr's cross-vein* throws down the strata 25 fathoms, whereas at *Wellgill cross-vein* the amount of vertical disruption is only 3 fathoms; and as the *great limestone* is 9½ fathoms thick, it follows that the vein adjoining it has limestone sides for 6½ fathoms (39 feet). The following section is an example of the nature, thickness, and succession of beds in this important mining district:—

	feet.
Plate, or indurated clay	18
Firestone (siliceous)	19
Plate	36
Pattinson's sill (siliceous)	10
Plate	25
LITTLE LIMESTONE	6
White hazle (siliceous)	1
Plate	18
Coal	1
Hazle	6
Plate	12
Hazle	5
Plate	16
GREAT LIMESTONE	57
Hazle (called *the tuft*)	13

	feet.
Plate	18
LIMESTONE POST	2
Plate	4
Hazle, called quarry hazle	18
Plate	22
Girdle, or till-bed	13
FOUR FATHOM LIMESTONE	23½
Plate and grey beds	8
Nattrass gill hazle	14½
THREE YARDS LIMESTONE	15
Grey beds	4
Six fathom hazle	56
FIVE YARDS LIMESTONE	12
Slaty hazle	26½
Plate	12
SCAR LIMESTONE	52
Hazle post	2
Plate	8
Hazle	3½
Hazle and plate	20
COCKLE-SHELL LIMESTONE	2
Plate	1
Plate and hazle	28
Hazle	18
POST LIMESTONE	6
Plate	6

Other models of MINES AND MINERAL DISTRICTS are in progress, and are intended to afford a comprehensive view of the great depositories of mineral wealth in different parts of the island, by showing at once the exact surface of the country, the order of super-position of strata, and the method of working pursued in some of the principal mines of the kingdom.

II.—IMPLEMENTS AND MATERIALS USED IN WORKING MINES.

Mankind are so much influenced by early habits and prevailing customs, that it is often difficult to introduce improvements, however obvious. The great facilities now afforded for locomotion are, however, gradually dispelling the mists of prejudice, and the traveller begins to reason on the intrinsic merits of what he observes. This remark is more applicable to miners than to any other class, because the nature of their occupation confines them to one locality, and that, from the nature of mining districts, is often a very secluded one. Hence it is obvious that a good collection of the best implements and materials used in different, and mostly far distant, mining districts and countries, may be of essential service. Such a collection has been already begun, and the names being attached to each, it is unnecessary here to enumerate them in detail, or to offer a description of objects of this class which can only be properly understood by inspection.

III.—MODELS OF MACHINERY FOR PUMPING WATER FROM MINES, RAISING MINERALS, AND FACILITATING THE DESCENT AND ASCENT OF MINERS.

1. **Machinery used at the commencement of Tin and Copper Mines, by Mr. T. B. Jordan.**—This model is made in accordance with the views of the director, that a national museum for illustrating the economy of mines should embrace the simplest as well as the most elaborate forms of machinery applicable to

the several stages of mining, in order that those who go out to our colonies may acquire a knowledge of those first rudiments of mining which they are most likely to be called upon to practise. A piece of rocky ground is represented by a carved block of wood, 4½ feet square and 2½ feet high, on which the geological character of the granite rocks and of killas is delineated: the former appearing in rounded masses or bosses in the back-ground, or highest part of the model, and the latter in the fore-ground. The line of junction of those rocks is shown at the ends of the model, on which also a section of the *lodes* or veins is represented. The following machines are represented on the surface of this model, on a scale of an inch to a foot.*

A HAND-WHIM, the simplest of all means for raising water, stone, or minerals, in buckets, and chiefly used in sinking shafts, or at very small mines. They may be seen of a truly primitive construction in some parts of Wales, where they are worked by females.

A SMALL WHIM, to be worked by one or two horses; and near it is the *head* (top), or commencement of a shaft.

A SMALL WATER-WHEEL, driving four STAMPS for stamping tin ore. The water, after leaving this wheel, is conveyed along a *launder* to another and larger WATER-WHEEL, on a lower level, and which works six STAMPERS. The ore and water are received into a *catch-pit;* and in front of the model is a *buddle* for washing the ore.

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* This is the most convenient and useful size for models: 1st, Because dimensions numbered in inches represent feet in the large work; 2nd, Because the pocket-rule of every workman contains scales of inches, eighths, or twelfths, by which means inches on the model may be easily measured; 3rd, Superficial or cubic inches in the model represent cubic feet in the large work, whence quantities, weights, and strength can be at once ascertained. The consistency of the various dimensions in Dean Swift's Tales of Lilliput and Brobdignag depends entirely on his having in the one case taken *one-twelfth*, and in the other *twelve times*, the original size. Models on the scale of one inch to a foot, therefore, exactly accord with the dimensions assigned to objects in Lilliput.

2. MODEL OF A CORNISH HORSE-WHIM FOR RAISING ORES, BY MR. T. B. JORDAN.—Scale, 1 inch to a foot. The diameter of the whim represented is 12 feet, and two or four horses may be employed in a walk 36 feet in diameter. The top of the shaft and doors show the manner in which the kibbles are landed, which (and this observation applies generally to working models) will be better understood by a brief inspection than by any description.

3. MODEL OF A DOUBLE-BUCKET WATER-WHEEL, BY J. BUDDLE, Esq.

The following notice of this model has been kindly furnished by Mr. Buddle.

The double bucket wheel is an ancient invention, as we find a wood-cut and description given of it in 'Georgii Agricolæ de re Metallica,' published at Dresden, about the year 1554.

This machine seems to have been extensively used, at that time, in the mines of Saxony, for drawing the ores; but we have no record of its being introduced into the coal mines in the North of England till about the year 1778.

About this time Mr. W. Brown, the most eminent colliery viewer in the North of England, constructed one of those machines, on a pit at Willington Colliery, near Newcastle-upon-Tyne, for drawing coals.

This first trial succeeded so well, that the use of the double bucket wheel *machine* soon became general in the Newcastle district on all the deep pits.

It rarely happened that natural streams of water could be applied to the working of those machines. The requisite supply was therefore obtained by forming capacious reservoirs, the water from which was pumped by steam engines into cisterns placed immediately above the wheel. It did not require a large supply of water to work those wheels, as the same water was used over and over again, being pumped back into the cistern again as soon as it was discharged from the wheel; the only waste, therefore, was the loss by evaporation.

These machines continued in general use until they were superseded by Boulton and Watts, and other rotary engines, about the year 1798.

4. MODEL OF A CORNISH WATER-WHEEL AND WHIM, BY Mr. J. ARTHUR, of Rhyd-y-mwyn Foundry, North Wales.—The water-wheel in this case turns only in one direction, and the requisite change of movement is effected by machinery, as is obvious on inspection. An index shows the positions of the ascending and descending kibbles for the guidance of the engine-man.

5. MODEL OF A WATER-BALANCE ENGINE, used in Wales for raising coal.

6. MODEL OF A STEAM WHIM (EAST WHEAL CROFTY), BY J. SIMS, Esq.—Scale, 1 inch to a foot; 6 feet 10 inches long, 3 feet 4 inches wide, 2 feet 7 inches high. The exterior only of the buildings containing the steam-engine and boiler are shown, the object of the

model being to show the mode of working the whims, and the facility of connexion with different shafts, obtained by means of the axis of the whim being vertical.

7. **Model of Cages used in drawing Coals** at the collieries in the North of England.

The following account of the cages, &c., represented in this model, has been kindly communicated to me by Mr. Buddle.

The tub or wooden box for drawing coals has been in use from time immemorial, when pits were only of small depth, and the quantities of coals drawn by horses were of very limited extent.

In those times neither cages nor slides were used to prevent the boxes from dashing against the sides of the pit, which, from the slowness of the motion, was of little importance.

When pits of greater depth were brought into operation, and greater speed was required, the unconducted box or tub could not be used, and its use was superseded by the wicker-basket or corf.

This mode of drawing coals became almost universal, and continued in general use for many years, till it occurred to the late Mr. John Curr, colliery viewer to the Duke of Norfolk, at Sheffield, about the year 1790, that the drawing of coals in tubs, guided up the shaft by slides or vertical railways, would be a great improvement on the mode of drawing coals by the wicker basket.

Mr. Curr* accordingly invented a mode of guiding the wooden boxes in the shaft by vertical wooden slide-rods placed against its sides, which he called *conductors.*

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* Mr. Curr was also the inventor of the cast-iron tram-way and flat rope.

Mr. Curr did not use a cage in which to place his boxes, but he suspended them from a wooden beam, which extended across the shaft between the opposite slide-rods. This beam had three friction wheels at each end, one on each side and one in the middle, so as to form a groove, which embraced the slide-rods or conductors. The engine-rope was attached to the middle of this beam, and had a brace-chain from it to each end of the beam to steady it. The horizontal beam and the two braces from its ends formed a triangle, by which name the apparatus was called. This system of drawing coals answered very well, and is still used in many of the Yorkshire collieries.

It however never prevailed in the Newcastle collieries, and the use of the corf or wicker-basket was continued till about the year 1830, when being found very expensive and inconvenient for dispatching the work at the deep new colliery of South Hetton, in the county of Durham, after trying other methods, that of drawing the boxes in cages, as shown by the model, was suggested by Mr. Thomas Young Hall, the colliery viewer, and has since been generally adopted in all the deep pits in the Newcastle district.

8. MODEL OF A WHEEL FOR A HIGH FALL OF WATER, BY CAPT. SAMUEL REID.—This ingenious and well-made model appears well adapted to obtain a circular motion from the direct operation of a high column of water. It is proposed to be worked either with steam or water, but the designer of it prefers the latter. The motion can easily be reversed by means of two cocks, or can be

stopped in an instant The *duty* (a Cornish term for the amount of effective power) has not yet been ascertained on a large scale, but the experiments hitherto made indicate a very favourable result.

9. MODEL OF PUMPS USED IN CORNISH MINES, BY Mr. J. ARTHUR.—The exterior of the engine-house, at the top of the model, is shown on a reduced scale, but the pumps are 1 inch to a foot. The following numbers are engraved on the model, and refer respectively to the several parts:—

1. Engine-house and stack.
2. Capstan shears.
3. Main beam and parallel motion.
4. Signal lever.
5. Main pump-rod.
6. Balance bob.
7. First pump of plunging-lift.
8. Clack-piece.
9. H-piece.
10. Wind-bore.
11. Plunger-hole and case.
12. First pump of the drawing-lift.
13. Working barrel, bucket, and clack of ditto.
14. Clack-piece.
15. Wind-bore.

10. MODEL OF A WATER-PRESSURE ENGINE AND PUMPS, used at the Alport Lead Mines, in Derbyshire, under the direction of JOHN TAYLOR, Esq., F.R.S., &c. —This large and valuable model has been made on the premises by Mr. Jordan, from designs furnished by the engineer. The mines at Alport are so heavily watered, that this mode of drainage is probably the

only one which could be applied with any chance of success. An adit level, or sough, is driven to the mines from the banks of the river Derwent, a distance of 3 miles, so as to drain the mines to the depth of about 22 fathoms; and the water from the workings below this level is raised by three large hydraulic engines, worked by abundant supplies of water from the rivers Lathkil and Bradford. One of these engines was erected, in 1803, by Mr. R. Trevithick, a Cornish engineer. This engine is a 25-inch cylinder, *double-acting*,—that is, the ascent and descent of the piston is effected by the pressure of water, a balance-beam being applied to relieve the engine of the weight of the piston, shaft, rods, buckets, &c., and to assist in lifting the load. The pressure on each square inch of the piston is about 57·3 lbs.; consequently the whole power of the engine is about 56,250 lbs. Another pressure-engine was subsequently made by Mr. Fairbairn, of Manchester, with a 36-inch cylinder, working single. The actual pressure under this piston is 58,300 lbs. Both these engines are subject to violent concussion by the mode of working, whence serious damages frequently ensue. The engine here represented was constructed at the Butterley works, from the designs of Mr. Darlington. The waste of water, and the weight and pressure on the valves are avoided, and by these and other improvements the concussion is reduced, and the speed may be increased with safety. These important objects have been completely attained.

In the model are represented—at A, a 50-inch cylinder; at B B, two cylindrical valves, 22 inches diameter and 22 inches long, for the admission and discharge of the water; at C C, two 4-inch valves, one acting with the cylindrical-valve, and the other with the discharge-valve ; they continue the supply and discharge for a moment after the 22-inch valves have closed, in order to complete the stroke of the engine ; D, supply sluice-valve for regulating the supply from the falling column, and shutting off the water entirely when necessary to do so ; E, sluice-valve for regulating the discharge.

The immense pressure upon the valve-pistons, which has always been found so objectionable, is entirely avoided by the cylindrical valves, and the blow or concussion on opening and closing is very small.

The engine will work five 10-feet strokes per minute without injury to the machinery. The pressure under the piston is 112,500 lbs. It will lift about 21½ fathoms (129 feet) by a 42-inch plunger ; the load will therefore be 77,500 lbs., without friction. It requires 852 gallons of water per stroke to work it, and will discharge 600 gallons per stroke, or 3000 gallons per minute.

11. **Model of the Turbine, made by Mr. T. B. Jordan.**—The turbine consists of three principal parts—1st. A cylinder with a base, on which are fixed the guide-curves, directing the water at a certain angle upon the buckets of the moving ring.

2nd. A sluice regulating the flow of water from the bottom of the cylinder upon the buckets ; and,

3rd. The external or revolving ring, with its buckets and an upright shaft, whence the motion is communicated to the machinery to be driven.

The buckets are confined between two annular plates, the lower one being attached to the vertical shaft, in the bottom of which is fitted a hardened steel thimble, into which a pivot of "glass-hard-steel" works. This inversion of the ordinary arrangement of the pivot is to prevent any particles of sand or other substances from getting upon the point and producing friction. The form of the buckets is a mathematical curve, and on the perfection with which this is traced will depend the efficiency of the turbine. The castings and iron-work composing this machine are, with the exception of the buckets, very simple: they require little adjustment, and only a few parts are turned or bored, so that the construction ought to be economical.*

This model is 12 inches square and 22 inches high, It is accompanied by a full-sized model of the turning-wheel, 2 feet in diameter.

12. MODEL OF A MACHINE FOR RAISING MINERS.—Scale, 1 inch to a foot. Size, 5 ft. 3 in. high, 2 ft. wide.

From statistical tables inserted in the Sixth Annual Report of the Royal Cornwall Polytechnic Society, it appears that "the occupation of the miner shortens his life by at least twenty years," and there is reason to believe that no small share of this is owing to the laborious descent and ascent of the miners by means of ladders, which entail much waste both of time and strength. To the use of ropes and chains, by which colliers and other miners in various parts of England make a safe and rapid transit to and from the dark chambers of the earth, a strong objection prevails in Cornwall, and in many cases the inclined direction of the shafts is unfavourable for their use. In order to remedy the serious results of the present usual mode of climbing by ladders, the arrangement shown by this model has been suggested, and is now carried into operation at Tresavean Mine, where the miners are raised from the depth of 240 fathoms (1440 feet); and I am informed by a respected and intelligent friend in Cornwall that the plan answers so completely, that it is in contemplation to complete the machinery to the depth of 300 fathoms. The saving of time and labour is very great, and the success of the experiments, after nine months' trial, is described as having equalled the most sanguine expectations. The expense has been considerable.

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* Abridged from Mr. Jordan's account of the turbine at the Institution of Civil Engineers, March 22, 1842, when Professor Gordon read "Remarks on Machines recipient of Water-Power, more particularly the Turbine of Fourneyron." This valuable paper gave rise to an interesting discussion, which extended over several evenings, and the substance of which is inserted in the "Minutes of Proceedings" of that Institution, 1842, page 92.

13. MR. BOOTH'S APPARATUS FOR RAISING AND LOWERING MINERS, MINERALS, &c., FROM MINES.—Mr. J. P. Booth, of Cork, has recently patented certain arrangements for effecting the above objects, and also for facilitating the ventilation of mines, &c., models of which are in preparation by him to be presented to this collection. His plan consists of a *revolving inclined plane*, or continuous *screw*-shaft, the threads or surfaces of which are made to act against the peripheries of wheels extending from a carriage containing the miners or minerals, &c.; and power is derived for working a ventilating apparatus from the rotation of the screw-shaft.

IV.—MODELS OF MACHINERY AND APPARATUS FOR WASHING AND DRESSING ORES, AND OF FURNACES, MILLS, &c., IN WHICH ORES ARE SMELTED AND CONVERTED INTO FORMS SUITABLE FOR COMMERCIAL AND MANUFACTURING PURPOSES.

1. Model of a Tilt-Hammer, occasionally used in Cornwall and elsewhere, for breaking up large masses of poor copper ores.

2. Model of a Crushing-Machine for breaking Copper ore.—Scale, 1 inch to a foot. The water-wheel represented is 24 feet in diameter. The ore is placed in a *hopper* at the top, and falls down so as to pass between two very strong cast-iron rollers. A lever is attached, so as to admit of one of the wheels yielding for the purpose of relieving any excess of pressure. The ore having been thus ground (in the same manner that coffee is bruised in a coffee-mill), passes through an inclined revolving iron sieve of cylindrical form; the finer portion falls through the meshes of this sieve, and the coarser part rolls into a *launder*, which carries it to a *kibble*, in which it is raised up, and again passed through the crushing-mill.

3. Model of Steam Stamps, erected at Carn Brea Mine, by James Sims, Esq., C. E.—Scale, half an inch to a foot. Length of the model, 5 feet 3 inches; breadth, 4 feet; height, 2 feet 8 inches.

The tin ore is brought by railways or otherwise to *bins*, in which it is deposited. A *launder* or channel conveys a stream of water, which is made to drip down slowly upon the ore, and so carry it gradually under the *stampers*, where it is crushed by violent blows from heavy upright beams shod with iron, and passes through gratings or upright sieves of punched iron. The hard cast-iron head of each stamp weighs about 3 cwt.; the lift is 9 inches. There are 72 stamps, viz., 24 sets of 3 in each. A handle represents the engine-power, and by turning it the mode of operation is apparent.

4. MODEL OF A JIGGING MACHINE, used in Cornwall for washing copper-ore.—Scale, 1 inch to a foot. The power is a water-wheel, 14 feet in diameter. The ore having been brought from the crushing-mill, is placed in tubs with sieves, which are placed in tanks of water, and a vibratory movement separates the copper ore from the lighter materials mixed with it.

5. MODEL OF A GERMAN BUDDLE, OR SHAKING TABLE, PRESENTED BY JOHN TAYLOR, Esq., F.R.S.—Used for washing and separating the finest particles of ore, which have been carried away by the stream from previous processes, and been collected in *slime-pits*. The mode of operation is fully explained in the description of the following model.

6. MODEL OF AN IMPROVED BUDDLE, BY ROBERT STAGG, Esq.—The German buddle was introduced in the North of England lead-mines from a design furnished by Professor Mohs, but was not much used until

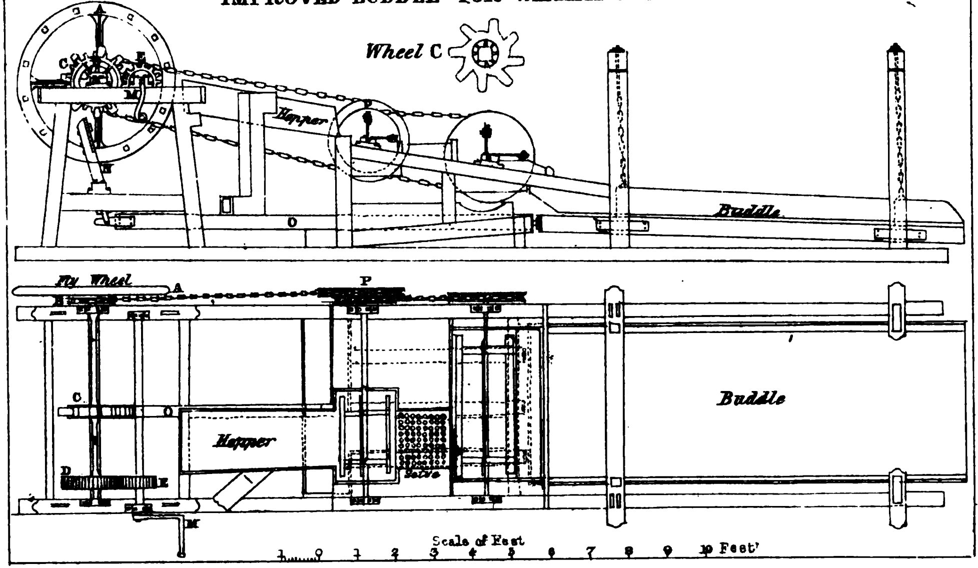
materially improved by Robert Stagg, Esq., the enterprising manager of the mines belonging to the London Lead Company. The wheel E (see diagram), turned either by a handle M, or by an attachment to steam or water power, turns the wheels A, B, C, D (the wheel C, being partly concealed, is drawn above). The strong wood-cogs of wheel C strike the arm N, which communicates a horizontal movement or vibration to the ram marked O. A strong iron plate is placed on the top of the arm to receive the blows from the cog-wheel C: this plate may be moved so as to adjust the requisite amount of vibration. The inclination of the buddle can also be accurately adjusted and varied from time to time, and upon this facility of adjustment the utility of the machine greatly depends.

The *slime* (a small portion of lead ore mixed with a large quantity of spar, &c., but all nearly in a state of fine powder from the result of prior operations) is laid in the hopper, where a due supply of water is furnished. It then passes into a box, where it is broken up, and freely mixed with water by the *first breaking wheel;* passing from thence over an iron sieve to separate straws or other extraneous matter, is again mixed up and separated by the *second breaking wheel*, and falls slowly over the *breast-board* into the *buddle*.

The buddle has a two-fold though scarcely perceptible movement, viz., one caused by the stroke of the ram, the other by a rebound from the two screw bolt-heads against which it falls. As the buddle becomes filled, the lower end of it is gradually raised by the screws at T, so as to cause a slow and regular movement, and thus separate the lead from the spar, &c.

Slime ore, which cost from 28*s*. to 30*s*. *per bing* for

IMPROVED BUDDLE FOR WASHING LEAD ORE.



washing in 1826 and 1827, was being washed for less than one-third of these prices in 1828; and some further improvements in this department have recently been introduced by Mr. Leithart, at Roughtengill Lead Mines, in Cumberland.

7. MODEL OF AN IRON FURNACE. 8. MODEL OF A PUDDLING FURNACE. 9. MODEL OF A HEATING FURNACE. 10. MODEL OF ROLLERS FOR ROLLING BARS.—An excellent description of the furnaces and of the processes of iron-making, with diagrams, is contained in No. 106 of the Library of Useful Knowledge ('Manufacture of Iron'), which can be obtained through any bookseller, price 6*d.* This cheap and useful book renders it unnecessary here to enter upon a detailed description of these models; and the series of this class is yet imperfect, the only one besides the above being a model of a LEAD HEARTH, presented by John Taylor, Esq.

V.—MODELS ILLUSTRATIVE OF SUCH GEOLOGICAL PHENOMENA AS ARE IMPORTANT TO BE KNOWN IN CONNEXION WITH PRACTICAL MINING, AND THE EXPLORATION OF MINERAL DISTRICTS.

1. MODEL TO ILLUSTRATE THE EFFECTS OF DENUDATION.—This is the first of a series of twelve models, by T. Sopwith, F.G.S., intended to explain several GEOLOGICAL PHENOMENA, which have an important bearing on practical mining, and on the exploration of new districts containing valuable minerals. It represents a square mass of part of the carboniferous or mountain limestone of Alston Moor, in the county of Cumber-

land, on a scale of 50 feet to an inch. The *seams* or beds of coals, it may be observed, are deposited in the same manner as the rest of the strata, and if these had remained unaltered in the position in which they were deposited, it is obvious that the upper rocks only would have been known to us. *Denudation*, by which large portions of these stratified rocks were subsequently washed away, formed the extensive valleys which now afford convenient means of access to the various strata, an advantage which will be better understood by removing the upper part of this model than by any description.

2. MODEL OF COAL STRATA NEAR NEWCASTLE-ON-TYNE, BY T. SOPWITH.—Scale, 5 chains, or 110 yards, to an inch. The undulating surface and *basset*, or cropping out, of a seam of coal, is the effect of denudation. The successive beds of coal are represented by lamina of ebony as follows:—

		Depth from surface.	Thickness of seam.	
		Yards.	ft.	in.
1.	*Monkton and Hebburn Fell seam*	40	2	10
2.	*Three-quarter coal*	204	1	2
3.	HIGH-MAIN COAL	264	6	0
4.	Metal-coal seam	278	3	0
5.	*Stone-coal seam*	292	0	8
6.	Yard-coal seam	312	3	0
7.	BENSHAM SEAM	336	4	8
8.	*Six-quarter coal*	366	2	6
9.	*Five-quarter coal*	374	2	8
10.	LOW-MAIN COAL	386	6	0
11.	*Crow coal*	406	0	10
12.	*Ryton five-quarter coal*	425	0	5
13.	Ryton Ruler coal	433	0	8
14.	Beaumont seam	470	3	5

The workings are delineated on the Bensham seam, the depth of which at Walls-end is about 870 feet, or more than twice the height of the dome of St. Paul's cathedral.

3. MODEL SHOWING THE DISLOCATION OF CARBONIFEROUS LIMESTONE, BY T. SOPWITH.—This model is in four parts, which may be separated, and thus exhibit—1st. The original position of strata; 2nd. The shifting or vertical displacement; 3rd. The appearance of the surface after the inequalities are removed. The line of displacement illustrates the nature of mineral veins, which are fissures in the strata, attended with more or less vertical movement of adjacent rocks.

4. MODEL TO SHOW THE FALLACIOUS APPEARANCES CAUSED BY SUCCESSIVE DISLOCATIONS, BY T. SOPWITH, F.G.S., representing calcareous, siliceous, and argillaceous strata, with thin seams of coal, which, by successive *faults* or dislocations, basset or crop several times on the surface, and thus present, on a cursory view, a fallacious idea of the strata beneath; for though several beds of coal appear at the surface, there is no considerable quantity beneath. An excellent illustration of these faults is given in Mr. Buddle's section of Jarrow Colliery, inserted in De la Beche's 'Sections of Views illustrative of Geological Phenomena,' plate 7.

5. MODEL SHOWING DISLOCATIONS OF COAL STRATA, BY THOS. SOPWITH.—In the model No. 4, the surface presents an apparent abundance of coal where scarcely any exists below; and in the present example, which corresponds with the condition of most of the large collieries in the kingdom, no coal appears at the

surface, although subject to considerable faults or dislocations below. The inclination of a vein is called its *hade;* and as a general rule, to which there are few exceptions, it may be observed, as shown in this model, that the vein *hades* or inclines with the bottom towards that side on which the strata are lowest. A curious horizontal section is presented to view by removing the upper portion of the model; and however singular the strata on some of the surfaces appear, the principle of construction of these models is at once a demonstration of their accuracy.

6. Model showing the INTERSECTION OF MINERAL VEINS, BY THOS. SOPWITH.—In this model the surface of a dislocated seam of coal is shown by supposing the superincumbent strata to have been removed. The vein represented by *white* wood, extending from 5 to 6, is the first formed vein; it *hades* or inclines with the bottom to the east, and the strata on the east side are thrown down 40 feet. Subsequently a second vein has been formed, and a further dislocation ensued, by which the rocks on the east side of the newly-formed vein have been thrown up 70 feet, and hence the seam of coal, which was originally a regular plane, like that shown in model No. 2, is separated into four parts; and taking the highest portion for a datum, one part is 40 feet, another 70 feet, and another 110 feet below it. It may readily be imagined what serious difficulties arise from these dislocations, and how important it is for the welfare of the country that a correct knowledge of them should be preserved. The instructive lessons which the vast mining operations of this country afford cannot be too carefully treasured, in order to avoid the waste of time and

capital, and the loss of life which may ensue, from opening mines which have been partially worked,—a danger which nothing but the preservation of accurate mining records can avert.

7. Model to illustrate the PHENOMENA OF MINERAL VEINS, BY T. SOPWITH.—The vertical cliffs caused by displacement of the strata do not now exist, having been removed by extensive denudation. The intersection of veins on such a denuded surface is often an extremely complicated problem, of which the present model is an example. In one part of the model it may be seen that the mineral vein, nearly vertical, is scarcely to be distinguished from the horizontal strata, but the true relations are apparent on examining the edges of the model.

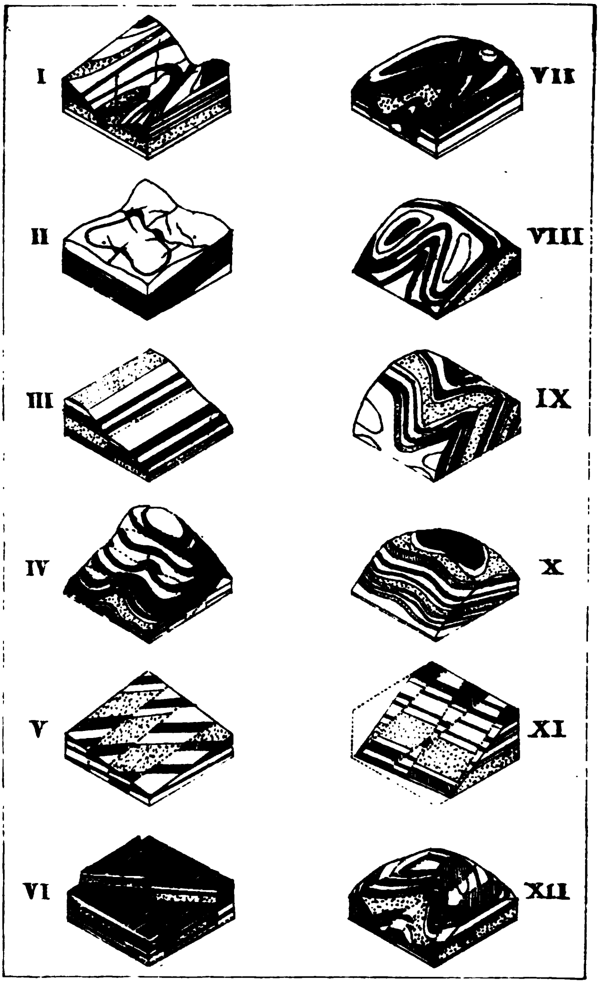
8. Model of OVERCUT STRATA, BY T. SOPWITH.—If the strata had remained in the nearly horizontal position in which they were deposited, any subsequent grinding away of the surface of any stratum would have worn off the upper portion, and denuded first the upper then the lower strata, which may in such case be said to be *overcut*, as shown in this model. In every case where the strata are overcut they form a V-like shape, *pointing up the valley*—the *highest* rocks *appear to be the highest*, and the seams of coal are to be worked above the place where they basset or crop out.

9. Model of UNDERCUT STRATA, BY T. SOPWITH.—It frequently happens that the strata are inclined at a steeper angle with the horizon than the surface of the country, in which case they may be said to

have been *undercut* by the process of denudation, as shown by this model. The V-like form of the strata now points *down* instead of *up* the valley, as in model No. 8. The *highest* rocks appear the *lowest*, and the coal is to be worked *below*, where it crops out. These terms of *overcut* and undercut apply to plane surfaces as well as to valleys; but steeply undulating surfaces have been selected, as affording the most striking illustration of these features, which are of great practical use in the observation of a mineral district.

10. Model showing the DENUDED BASSET OF INCLINED STRATA, BY T. SOPWITH.—The models hitherto explained have been either cases of horizontal strata, or of strata inclining in the same direction as that of the surface. In this model the strata are inclined in the opposite direction to the descent of the valley, and in every such case they are *undercut*, hence the V-like form tends upwards. The three models, Nos. 8, 9, and 10, form an epitome of the conditions under which stratified rocks are denuded, and of the characteristic marks by which their relative inclination, as regards the surface, may be ascertained.

11. Model to illustrate the VERTICAL INTERSECTION OF MINERAL VEINS, BY T. SOPWITH.—The strata represented in this model are dislocated by four mineral veins, and the plane surfaces of the model afford a clear view of the exact geometrical relations of the several rocks. Two sides show the original horizontal deposition, the other two sides the subsequent disturbance or dislocations; on one of these may be observed the *intersection of two veins on a vertical section;* by removing



GEOLOGICAL MODELS BY T. SOPWITH.

the upper part of the model the same intersection is shown on the *oblique plane;* and again, a horizontal surface on the base of the model, as it would be represented by the ordinary ground-plan of a mine.

12. Model showing DENUDATION OF MINERAL VEINS, BY T. SOPWITH.—The conditions of the strata are the same as in the preceding strata, but the denuded surface furnishes a view of the peculiar and frequently very perplexing appearance of such intersections of veins and disturbed strata.

Duplicate series of these twelve models, on a smaller scale, are deposited at the Geological Society of London and the Institution of Civil Engineers. They are also made up in sets, and may be had either as single models or in series of six or twelve models, with full explanations, fitted up in cases to resemble a book, and varying in price from four to six shillings for single models, and from two to five pounds for the respective series of six or twelve models.*

The following observations on these reduced or hand models appear in the President's address to the Geological Society in February, 1841. Speaking of a communication made to that society by the author, Dr. Buckland commented on the advantage of *expressing in a solid form those fractured conditions of the strata,* a right understanding of which is of the greatest importance both to the working of coal mines and of metallic veins. Many of the complicated phenomena of curvatures and complex intersections of plane surfaces cannot be adequately represented by any kind of geometrical drawings or plans.

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* Made and sold by T. and J. Sopwith, Newcastle-on-Tyne; and sold also by Mr. J. Tennant, mineralogist, 149, Strand.

"To the perfect knowledge and economical working of a mineral district, it is essential that the subterranean relations of all the strata should be correctly known, and expressed in an intelligible form. 1st. The original order of *stratification*. 2nd. The amount of *dislocation by fracture*. 3rd. The changes of the surface produced by *denudation*.

"The deceptive appearances frequently caused by faults or fractures are represented by making the models moveable in the direction of these faults, so that the strata may be restored to their original position, and again shifted or dislocated. The still further difficulties that arise from the denudation of the upper portions of the dislocated strata can be adequately expressed only by the solid *fac-simile of nature* which a model affords.

"Among the subjects represented in the models prepared by Mr. Sopwith, are the relative position, depth, and upcast and downcast dykes of the component strata of the Newcastle coal-field, and the strata of the great carboniferous limestone series, with their numerous intersections by mineral veins, in the extensive lead-mine districts of Alston Moor and Crossfell.

"All the varied and complex phenomena of these highly valuable repositories of coal and lead, which are continually perplexing and impeding the progress of the practical miner, are made perfectly intelligible when their details are expressed in a dissected model. The mercantile value also of these mineral districts is obviously dependent, first, upon a correct knowledge of the amount of coal and mineral veins which they may contain; and, secondly, upon a knowledge of the most advantageous methods of extracting their contents.

Cases are often exhibited in these models of deceptive indications of coal upon the surface, when, in consequence of complex faults, small portions only of the broken strata remain below; whilst in other cases many and valuable beds of coal may exist below, where few or no traces of it appear upon the surface.

"Mr. Sopwith has founded these models on observations made during extensive practice, as a mineral surveyor, at Newcastle and Alston Moor. The principle of their construction is available to represent all kinds of geological phenomena, and has been applied by him on a large scale in a model of the entire coal-field of the Forest of Dean, in which the exact extent and thickness of each bed of coal becomes instantaneously apparent on the removal of the upper laminæ of the model; each component stratum of the coal-field being represented in its proper place by a moveable stratum of wood, on which a register may be kept of the quantities of coal that are from time to time extracted in the collieries. The model also at once indicates the most advantageous mode of working every portion of the coal-field.

"It is of no small importance to the future welfare of the nation, so dependent as we are become for our commercial prosperity upon a continued supply of mineral fuel, that similar models to that of the Forest of Dean should be also made of other coal-fields, and preserved in the Mining Records Office, attached to that department as permanent registers of the amount of coal which is year by year extracted from each of these subterranean main-springs of our commercial activity. By reference to such models, an estimate may at any time be formed of the quantity of coal that remains for future consumption, the amount of which will be the measure of the possible duration of our country's exalted position among the kingdoms of the earth."

13. Model to illustrate the GEOLOGICAL PHENOMENA of the mining districts of Cornwall, by Mr. T. B. Jordan. —This explanatory key to a knowledge of the principal features of Cornish *lodes*, *cross-courses*, &c., is 28 inches long, 20 inches wide, and 7 inches high. One-half of the model exhibits *killas* or clay-slate, represented by *beech-wood*. The rest is formed of *mahogany* to represent *granite*. Both these are traversed by pieces of yellow Brazil-wood, representing *elvan courses*, (see page 17, and also specimens of elvan in the first apartment of the Museum of Economic Geology). These *elvan courses* and *lodes* or veins, represented by *ebony*, run in directions approximating to east and west. The occurrence of *tin ore* is represented by tin, and of *copper ore* by pieces of *copper* inserted in the model.

The *cross-courses* extend in a nearly north and south direction, and are represented by *sycamore* containing pieces of dark-stained wood to indicate *lead*, and of *rosewood* for *iron*. At the *south end* of the model is part of the sea shore; and the mode of occurrence of stream tin is represented with the superincumbent detritus shown by brown-coloured wood.

An index placed on one edge affords a ready key to these various features. The model separates or slides apart, so as to show the junction of the *granite* and *killas*; and the *heaves*, or shifting of the *lodes* by the cross-courses, may also be studied.

14. Model to illustrate the SUCCESSION OF STRATA AND GEOLOGICAL PHENOMENA of part of the great COAL AND IRON DISTRICTS OF SOUTH WALES, by Mr. T. B. Jordan, from sections and designs by Sir Henry De la Beche.—This is a large model constructed on the same principle as the series of twelve models already described. Like them, the section or succession of strata is *accurately copied* from an actual measurement of the rocks, and also, like them, the surface does not profess to represent any particular tract (as in the models of the first class, described at page 62), but it expresses those general features which are of constant occurrence, and adheres to the exact phenomena which characterize the geological conditions of the strata. By this means, as in model No. 13, also, a large amount of information is comprised in a small compass, which could not have been done if any particular tract had been selected. It admirably represents the successive strata, the undulations of the surface, and the various forms assumed by the edges of the basseting strata, according to the contour of the surface and the *relative inclination* of the beds, as already explained. The method of working seams of coal and iron is also delineated on some of the beds, and the separation of the model into different parts affords a most instructive view of the composition of this vast mineral deposit. It also exhibits in a striking manner the fallacious nature of many of the calculations which are made as to the duration of coal and iron ; for it is obvious that the economy of production from seams or veins lying near the surface, which now gives us a national superiority, cannot extend to those deeper situations in which a large portion of the minerals are buried, and where *increased temperature and danger from inundation*

from land workings must be added to other elements of increased labour and expense.

15. Model of the ISLAND OF ARRAN, by Mr. Andrew C. Ramsay.—This island, which scarcely exceeds 20 miles in length and 10 in width, has been described as comprising an epitome of the geology of the globe. The model is formed of papier-mâché, and the vertical scale is nearly that of the horizontal. The geological character of the component rocks is expressed by vivid colours, of which *deep pink* for *granite*, and *dark green* for trap, porphyry, &c., are the most conspicuous. Duplicates of this interesting model have been published by Mr. Ramsay, who has also written an exceedingly interesting book,* entitled, 'The Geology of the Island of Arran, from an original Survey,' price four shillings. In addition to an admirable account of the geology of the island, it contains an engraved map and sections, with twenty-four explanatory views and diagrams, and eminently deserves a place in the library of the geologist, and of every lover of picturesque scenery.

16. Model exhibiting the GREAT LAND-SLIP ON THE COAST OF EAST DEVON, BETWEEN AXMOUTH AND LYME REGIS, which took place on the 26th December, 1839, constructed and presented by Mr. W. Dawson, C.E., of Plymouth, from measurements made by him in 1840.—The length of the chasm, from east to west, made by this extraordinary land-slip or founder is about 3000 feet, and its width at the east end is 430 feet, and depth 165 feet; in the centre it is 365 feet wide and 210 feet deep, and at the west end 200 feet wide and 130 feet in depth. The scale of the model is two chains

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* Richard Griffin and Company, Glasgow; and Thomas Tegg, London.

(132 feet) to an inch. The particulars of this and some similar phenomena on the same coast have been published by Mr. Murray, in a series of plans and sections, representing this vast subsidence of the land and elevation of the bottom of the sea, and accompanied with an elaborate dissertation by the Rev. W. D. Conybeare, and picturesque drawings by Mrs. Buckland.

VI.—PLANS AND SECTIONS OF MINES AND MINERAL DISTRICTS.

The great value of mining records has been commented upon in the introductory observations (page 49), and arrangements have been made in accordance with the views expressed by the memorial of the British Association. These plans and sections are placed in the custody of Mr. T. B. Jordan, keeper of Mining Records, of whom information respecting this department may at any time be obtained: they are preserved in suitable cabinets, together with the engraved plans of Great Britain and Ireland, published from the surveys of the Ordnance Department, and especially those coloured copies of the same which comprise the result of the Ordnance Geological Survey, conducted by Sir Henry De la Beche. The detailed maps and sections made during the extensive explorations of the numerous and able assistants employed on that service, together with the notes and illustrative sections made by Sir H. De la Beche, who has devoted a great portion of his time to this survey during the last ten years, will form a valuable feature in this collection. The number and voluminous nature of documents of this description of course prevents their being kept otherwise than in cabinets or drawers properly indexed, and the information they convey is adapted rather for occasional reference by parties directly interested, than for indiscriminate exhibition to the public. Some of those plans and sections, however, which possess a general interest, are placed in convenient situations on the walls of the apartments, and additions will from time to time be made to this class, of which the following are examples :—

1. Plan of the Coal and Iron Mine Districts in the Forest of Dean, surveyed by Order of Her Majesty's Commissioners of Woods and Forests, and Land Revenues, by T. Sopwith, F.G.S., 1835.—That part of the Forest of Dean and Hundred of St. Briavals, in which the mines are chiefly situated, extends over an area of which the extremes are respectively eight miles from north to south, and a like distance from east to west, thus forming an area of sixty-four square miles, represented on the map by sixteen sheets pasted together.

Each sheet comprises an extent of four square miles, shown by parallel lines, one mile apart, each line having a scale upon it, so that in the event of the paper contracting, the scale is permanently fixed in immediate proximity to the objects represented.

The delineation of surface objects in this plan is confined to roads, railways, rivulets, boundaries of the forest, and of its several enclosures; and of such objects generally as are easily recognized, and of a description not liable to sudden or frequent alteration, avoiding those minute details which, on a complete surface plan, would interfere with the clearness of the subterranean delineations. The several seams or veins of coal are represented by parallel lines, at the distance of ten yards apart, according to the scale; by which means an approximate idea of small distances and areas may easily be formed. These lines are either parallel with, or inclined at, certain angles with the top and bottom edges of the plan, each variety of inclination designating a particular seam or vein of coal. The extent of shading, on the plan, represents that portion of each vein which has been worked out or exhausted; and the principal works in operation when the plan was constructed are shown by strong lines, straight, wavy, or dotted, &c., as described by a reference. Sections of the several seams of coal, and tables of their specific gravity, and of the elevation of the surface, &c., are inserted in convenient places on the plan. In one corner is an index map of the whole, by which any work may be easily found; and it is extremely useful as a reference when the plates are bound up in a volume 20 inches square, instead of being pasted together. As impressions can be taken from the copper-plates at a small expense, these engraved plans not only proved of great use during the investigations of the Dean Forest Mining Commission, but copies of them have been printed by order of Government, for the use of all parties interested in the same; and this method of preserving mining records possesses great advantages when considered in connexion with the vast importance of a knowledge of the mineral treasures of this country.*

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* For further particulars of this map, and of the interesting mining district which it illustrates, see 'The Award of the Dean Forest Mining

3. Isometrical Plan of the Lead Mining District at Nentsberry, in Alston Moor, in the County of Cumberland. By T. Sopwith, F.G.S. —Horizontal and vertical plans and drawings are so commonly used as to be generally well understood. In both these modes of projection the eye is supposed to be at an infinite distance, so that no one part of the surface represented appears less than another, which would be the case if the point of view was considered as being within any finite distance, however great. The horizontal plan and vertical section afford a correct idea of the respective planes which they represent, but they comprehend such objects only as are exactly upon each plane, or parallel to it. In order, therefore, to represent different portions of a mining district, a number of separate plans and sections are required; but by isometrical projection, the surface of the country, the interior of mines, and a number of vertical sections may be comprised in one drawing, the clear and explanatory effect of which is here exhibited.

The district represented in this drawing is about half a mile, and is nearly midway between the town of Alston and the rich mining district at Nenthead. In the left-hand corner is part of the great aqueduct, or water level, called Nent-force Level, commenced by

Commissioners under the Act of 1 and 2 Vict., c. 58, as to the Coal and Iron Mines in her Majesty's Forest of Dean, and the Rules and Regulations for working the same, with Preliminary Observations, and an Explanation of a Series of Sixteen Engraved Plans of the Dean Forest Mines, by T. Sopwith, F.G.S., the Commissioner appointed on behalf of the Crown. Published by order of the Commissioners of Woods, Forests, &c. London: John Weale, 1841. Price 5*s*.'

The series of sixteen plans is sold at 1*l*. 4*s*., or any sheet may be bought separately for 2*s*. of Mr. Weale, or of any bookseller.

the celebrated Smeaton in 1775, and extending from Nentsberry shaft to the town of Alston, a distance of 3¼ miles. An adit is continued, as shown on the plan, on the top of the *Scar Limestone.* Near the top of Nentsberry shaft is the entrance or level mouth of *Wellgill Cross Vein Lead Mine*, the works of which are shown in the *Great Limestone.* The strata are intersected by *Old Carr's Cross Vein*, which *throws down* the strata on the east side 25 fathoms (150 feet). These and numerous surface and subterranean features, together with six vertical sections, suffice to show that whenever it is desirable to combine several geological sections in one drawing, this method of projection affords the means of doing so. The escarpment and surface of rocks may be represented so as to show the connexion of the several beds or strata of which they are composed. Outlines of the surface of a mountainous district may be represented in various directions, and coloured so as to denote the basset of different strata. Isometrical projections may be made either from given measurements, or from ordinary plans and sections, by a process much more simple and easy than the rules of common perspective. They approach more nearly than any other mode of drawing to the clearness of a model.*

4. PLANS AND SECTIONS OF HOLYFIELD, HUDGILL CROSS VEIN, AND SILVER BAND LEAD MINES, IN ALSTON MOOR AND TEESDALE.—These plans are engraved on copper-plate, and do not vary from ordinary plans and sections, except as being illustrations of a

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* These mines, &c., are described in 'An Account of the Mining Districts of Alston Moor, Weardale, and Teesdale, by T. Sopwith, &c.' The method of constructing such plans is fully explained in his Treatise on Isometrical Drawing.

method of preserving mining records, which combines great economy with extensive usefulness. The existing workings of mines are proposed to be surveyed and engraved for the purpose of being supplied to the owners, lessees, managers, and other parties; and the additional workings could afterwards be annually inserted on the plan, at an expense exceedingly small in comparison with the advantages to be derived from them. Mining, however speculative, is not entirely the work of chance. It has derived, and is every day deriving, advantages from the skilful application of science, which, in proportion as mines become exhausted, must be essential to their being worked at all; and it is obvious that, both for present use and future reference, a record of the subterraneous workings of mines, regularly continued, must be of great utility, and will enable the present as well as the future proprietors of mines to form a correct judgment of mining operations, which, in too many cases, are now imperfectly understood, and will hereafter be wholly lost in oblivion.

Although no legal obligations exist by which mining records are registered, the subject is of too great importance long to escape public attention; and, in the meantime, the reasons adduced in these pages, and the facilities afforded by Government in this institution, cannot fail to direct the attention of the owners and occupiers of mines to the great advantage of a permanent place of deposit for plans and sections, and other documents relating to the several mines throughout the kingdom; and any plans lent for the purpose of being copied may be addressed to the Commissioners of Woods and Forests, Whitehall-place, for the Museum of Economic Geology, and will be safely returned to the owners.

VII. RAILWAY SECTIONS, ILLUSTRATING THE GEOLOGY OF THE DISTRICTS PASSED THROUGH.

At the meeting of the British Association, held at Glasgow in 1839, a committee was appointed to take measures for procuring coloured drawings of the railway sections before they are covered up, and the sum of 200*l.* was placed at their disposal for that purpose.

In pursuance of these resolutions a blank chart was prepared by Professor Phillips of York, numerous copies of which were circulated. The subject was also brought under the notice of the Institution of Civil Engineers in a paper read by Mr. Sopwith, February 2, 1841. The charts on which the sections are drawn are engraved in small squares of one foot each, on a scale of 40 feet to an inch, and contain a space equivalent to 800 feet in length and 600 feet in height, so that the sections are delineated in their true vertical and horizontal proportions. There remains in every case a portion of the chart unoccupied by the section, which affords convenient space for enlarged sections in detail, or for drawings of fossil remains. Considerable progress has been already made in this collection; among which are—1st. A geological section of the cuttings of the GREAT WESTERN RAILWAY between Bristol and Bath, by Mr. Sanders, with numerous enlarged drawings of organic remains. 2nd. Geological sections of cuttings on the HULL AND SELBY RAILWAY (about 20 miles). 3rd. A similar geological section of the BOLTON AND PRESTON RAILWAY. 4th. Geological sections of the MANCHESTER AND BOLTON RAILWAY (about 11 miles). These sections exhibit the details of the strata and the position in which the remarkable fossil-trees were found. 5th. Plans and sections of the MANCHESTER AND LEEDS RAILWAY from Manchester to Normanton (about 50 miles). The four last-named sections have been prepared for the Committee by Mr. J. Robison Wright. 6th. Geological sections of railway cuttings between PAISLEY AND GREENOCK, and between GLASGOW AND PAISLEY, by Mr. John Craig, Glasgow. 7th. Outline sections of the whole of the MIDLAND COUNTIES RAILWAY from Rugby to Derby and Nottingham (about 68 miles). 8th. Plans and sections of the whole of the NORTH MIDLAND RAILWAY from Derby to Leeds (about 72 miles), with geological details furnished by Mr. Swanwick. 9th. Outline sections and plans of the BIRMINGHAM AND MANCHESTER RAILWAY. 10th. Similar plans and sections of the SHEFFIELD AND MANCHESTER RAILWAY. 11th. The same of the NORTH UNION RAILWAY; and 12th. The same of the LIVERPOOL AND MANCHESTER RAILWAY.

Several of the outline sections are not yet filled in with the geological detail; but the value of the series already collected is so apparent that the efforts of the British Association will probably be sanctioned and followed up by Government; especially as it is most probable that the Mining Records Office, where they are now deposited, will be considered by the British Association as the most suitable and convenient place for them to remain permanently; as they can thus be consulted along with other similar records of the geology and mining of the country.

The following is a list of the Railway Sections Committee, from any of whom information may be obtained by parties desirous to promote the objects they have in view :—

RAILWAY SECTION COMMITTEE, BRITISH ASSOCIATION.

The Marquis of Northampton,	John Taylor, Esq.
Rev. Dr. Buckland,	Chas. Vignoles, Esq.
Sir H. T. De la Beche,	Thos. Sopwith, Esq.

Copies of the engraved charts will be furnished gratuitously to engineers or others who may be disposed to furnish sections, on application to Mr. T. B. Jordan at the Museum of Economic Geology.

VIII.—INSTRUMENTS USED FOR SURVEYING, LEVELLING, AND DELINEATING PLANS, SECTIONS, AND ISOMETRICAL DRAWINGS OF MINES.

With a view to the preservation of mining records, it is important that the managers of mines should have opportunities of becoming acquainted with the instruments and methods of surveying and drawing used as well on the continent as in different parts of Great Britain. This department will therefore contain a collection of the best surveying and levelling instruments, as theodolites, spirit levels, &c., accompanied with explanatory memoranda. The complete developement of the arrangements of the institution will include lectures in which these and other subjects connected with the study of economic geology will be illustrated, with a view to promote as much as possible the progress of improvement in surveying and working mines, and in preserving permanent records of what has been done in those great depositories of national wealth.

LABORATORY.

Attached to the Museum is a Laboratory, which is placed under the superintendence of Mr. Richard Phillips, F.R.S., the curator of the museum. Pupils are received at very moderate charges, and instructed in analytical chemistry, especially as applied to agriculture and metallurgy. The analysis of soils and minerals is also undertaken for the public at fixed and moderate charges. The specimens in the museum are subjected to chemical examination, and the results are placsd beside the specimens for the information of the public (see pages 3 and 36 for notices of the appointment of Mr. Phillips, and of the accurate and detailed manner in which his well-known talents have been applied to the public service in the performance of his duties as curator).

The preceding notices, however brief and imperfect, will, it is trusted, convey to those who have not visited the museum an idea of the interest and utility which it possesses. Hitherto the very existence of the museum has been scarcely at all known; nor is the plain and unostentatious dwelling which contains it different in external appearance from a common dwelling-house. Those, however, who avail themselves of the gratuitous admission now sought to be made generally known by this publication will soon perceive that it already contains the germs of a great national institution, the extent and importance of which will doubtless be commensurate with the objects which its promoters have in view. Whatever class of persons visits it—however varied in rank, in attainments, in occupations, or pursuits—it is not too much say, that each and every one may derive both solid instruction and lively gratification from its contents. Refined taste and sound judgment will dwell with satisfaction on the evident tendency of this museum to establish a correct feeling for art by the study of the best examples, and to base that feeling on a regard for the durability of materials as well as beauty of execution. The nobility and landed proprietors are here presented with a collection of the true sources of wealth which the kingdom contains—its subterranean stores of coal and iron, its rich ores of copper, lead, and tin—its massive granites, its beautiful marbles, its abundant materials for decoration, and the constituent elements of its fertile soils, are all presented to view, enhanced by the captivating illustrations of gems of art, and the not less valuable illustrations afforded by geology and chemistry. The general arrangement of rocks and the interior workings of mines are rendered apparent by explanatory models. The antiquary and the architect can examine the structural materials of the most ancient and venerable and extensive fabrics throughout the country, and apply the inestimable knowledge thus afforded to avoid the errors of former builders, and to perpetuate all future works by the selection of suitable materials. The miner may here examine with greater comfort and with better and more numerous and compact examples than even the mine itself affords, the various phenomena of mineral veins, whilst at the same time he gathers comprehensive views from the study of the features of various and widely-separated mineral districts represented by plans, sections, and models, in forms which impart a clear idea of the points most important to be noticed. The manufacturer and the artisan may here become acquainted with the nature and economic value of the materials they employ; and even the general observer, the man of reading and observation, or those, and they are many, of the fair sex who delight in improving a taste for art, and in acquiring a general knowledge of popular departments of science, may here spend many an hour both pleasantly and profitably.

"Lo, Vanity, with dazzling gems adorned,
Flaunts proudly by!
While Science pores upon a specimen
Rough from the bosom of its native mine."

The lessons which are here unfolded tend directly to individual enjoyment; to the happiness of the family circle; to the improvement of agriculture, arts, and manufactures; and not less directly do they tend to the welfare of a nation like this, based as are the very elements of its existence on those useful applications of mineral wealth which it is the express object of the study of economic geology to extend and improve.

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The following index is intended, not so much as a reference to the preceding descriptions (which are, in many instances, only a brief enumeration of the principal contents of the Museum), as for the purpose of assisting those who may wish to examine any particular department. By turning to the respective pages, it will be seen in what part of the Museum the required illustrations are deposited. Many of the ores and other specimens, and works of art, are indexed under different heads, and classified, so far as is necessary, to guide the visitor to the leading features of the collection.

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